Supreme Court, U.S.
FILED

95-1096

OFFICE OF THE CLERK

No. 95-

Supreme Court, U.S.
FILED
DEC 26 1995
CLERK

IN THE
SUPREME COURT OF THE UNITED STATES
OCTOBER TERM, 1995

MICRON SEPARATIONS, INC.,
Petitioner,

v.

PALL CORPORATION,
Respondent.

On Petition for a Writ of Certiorari
to the United States Court of Appeals
for the Federal Circuit

PETITION FOR A WRIT OF CERTIORARI

STEVEN M. BAUER
Counsel of Record
JOHN J. COTTER
TESTA, HURWITZ
& THIBEAULT
125 High Street
Boston, MA 02110
(617) 248-7000
Attorneys for Petitioner,
Micron Separations, Inc.

18 pp

QUESTIONS PRESENTED

1. In a patent infringement action in which the accused product is clearly outside the literal scope of the patent claim (*i.e.* where the patent claim requires a nylon resin to have a ratio in the range of "about 5:1 to about 7:1," and the accused product has a ratio of 4:1), whether the court can ignore the express limitations of the claim to conclude that the product infringes under the "doctrine of equivalents."

2. On an appeal from an action to recover patent infringement damages, whether an appellate court can issue an order vastly increasing the damages award based solely on evidence that the trial court excluded and that the defendant never had an opportunity to rebut.

LIST OF PARTIES TO THE PROCEEDING PURSUANT TO RULES 14(1)(b) and 29.1

The names of all parties in the court whose judgment is sought to be reviewed appear in the caption of this Petition for Writ of Certiorari.

LIST OF PARTIES PURSUANT TO RULE 29.1

Petitioner Micron Separations, Inc. does not have any parent companies or subsidiaries.

TABLE OF CONTENTS

Page

QUESTION PRESENTED i

LIST OF PARTIES TO THE PROCEEDING PURSUANT TO RULES 14(1)(b) AND 29.1 ii

LIST OF PARTIES PURSUANT TO RULE 29.1 ii

TABLE OF CONTENTS iii

TABLE OF AUTHORITIES vi

OPINIONS BELOW 3

JURISDICTION 3

STATUTORY PROVISIONS INVOLVED 4

STATEMENT OF THE CASE 7

1. Procedural History 7

   A. The Court Agreed MSI's Product Does Not Fall Within The Literal Claim Scope 8

   B. The Damages Award 9

2. Similarities Between This Case And *Hilton Davis* 10

REASONS FOR GRANTING THE WRIT 15

I. THE DOCTRINE OF EQUIVALENTS ISSUE PRESENTS A FUNDAMENTAL QUESTION OF PATENT LAW THAT REQUIRES SUPREME COURT RESOLUTION 16

II. IN INCREASING DAMAGES, THE FEDERAL CIRCUIT IGNORED THIS COURT'S PROHIBITION AGAINST RULING ON EVIDENCE NOT INTRODUCED AT TRIAL 21

CONCLUSION 23

APPENDIX

A. Opinions of United States Court of Appeals for the Federal Circuit (September 26, 1995)..... 1a

B. Memorandum and Orders of United States District Court for the District of Massachusetts in Favor of Plaintiff and Against Defendant (May and June, 1991) ... 30a

C. Order of United States Court of Appeals for the Federal Circuit denying Petition for Rehearing (October 24, 1995)..... ... 112a

D. Judgment, United States Court of Appeals for the Federal Circuit (September 26, 1995)..... 113a

E. Excerpts from United States Patent and Trademark Office file history for United States Patent No. 4,340,479 ..... 114a

TABLE OF AUTHORITIES

Cases — Page

Ballard Medical Products v. Wright, 821 F.2d 642 (Fed. Cir. 1987). 22

Graver Tank & Mfg. Co. v. Linde Air Products Co., 339 U.S. 605 (1950) 11, 20

Hilton Davis Chem. Co. v. Warner-Jenkinson Co., 62 F.3d 1512 (Fed. Cir. 1995) (*en banc*) (petition for cert. pending, *Warner Jenkinson Co. v. Hilton Davis Chem. Co.*, No. 95-728, filed Nov. 6, 1995)..... *passim*

Markman v. Westview Instr., Inc., 52 F.3d 967 (Fed. Cir.) (*en banc*), *cert. granted*, 64 U.S.L.W. 3238 (No. 95-26, granted Sept. 27, 1995) 18

Quantum Corp. v. Rodime, PLC, 65 F.3d 1577 (Fed. Cir. 1995) 15, 18

Singleton v. Wulff, 428 U.S. 106 (1976) 22

Statutes

28 U.S.C. § 1254 3

35 U.S.C. § 111..... 4

35 U.S.C. § 112..... 4, 15, 17

35 U.S.C. § 251 ..... 5, 14, 15, 17

35 U.S.C. § 271 15

35 U.S.C. § 281 281

35 U.S.C. § 304 18

35 U.S.C. § 305 ..... 6, 15, 18

IN THE
SUPREME COURT OF THE UNITED STATES
OCTOBER TERM, 1995

MICRON SEPARATIONS, INC.,
Petitioner,

v.

PALL CORPORATION,
Respondent.

PETITION FOR WRIT OF CERTIORARI

Micron Separations, Inc. ("MSI") respectfully petitions for a writ of certiorari to review the judgment of the United States Court of Appeals for the Federal Circuit, which judgment relies on the Federal Circuit's recent decision in *Hilton Davis Chem. Co. v. Warner-Jenkinson Co.*, 62 F.3d 1512 (Fed. Cir. 1995) (*en banc*) (petition for cert. pending, *Warner Jenkinson Co. v. Hilton Davis Chem. Co.*, No. 95-728, filed Nov. 6, 1995). The present case, like the *Hilton Davis* case for which a petition for certiorari is now pending, involves a question of fundamental importance to patent law -- how far may infringement under the doctrine of equivalents go when the accused device clearly does not fall within the literal meaning of the patent claim at issue?

The petition for a writ of certiorari now pending before this Court from the *Hilton Davis* case raises and fully identifies many of the same doctrine of equivalents issues

that apply in this case. This case, and *Hilton Davis,* each involve (i) membrane technology, (ii) a chemical patent claim limitation specifying a range of values which was narrowed during the patent application process, and (iii) an accused product or process well outside the claimed range. In view of the similar facts and identical legal issues in the two cases, if this Court grants certiorari in the *Hilton Davis* case, it should also grant certiorari in the present case. If certiorari is granted in *Hilton Davis,* but not in this case, a multimillion dollar judgment against Petitioner MSI threatens its existence, and a subsequent reversal of *Hilton Davis* would come too late to save it.

In addition, this case involves an important question of the scope of an appellate court's power to make findings based on a one-sided testimonial record, without the benefit of either trial court findings or rebuttal evidence on the issue. The appellate court here, based on evidence that the trial court excluded, ordered that damages for lost profits be recalculated upward. This result is unfair because the defendant will now be required to pay substantial additional damages based solely on evidence it never had the chance to rebut. Once again, the Federal Circuit has confused its role regarding facts and law. This Court should grant certiorari to review the proper role of the appellate court regarding "facts" that have not been proven below.

OPINIONS BELOW

The Court of Appeals opinions are reported at 66 F.3d 1211 (Fed. Cir. 1995), and are reproduced beginning at Appendix page la. The district court opinion reviewed by the Court of Appeals is not reported, and is reproduced beginning at Appendix page 30a. The district court issued a subsequent written opinion after the appeal was filed and briefed, reported at 792 F. Supp. 1298 (D. Mass. 1992).

JURISDICTION

The Court of Appeals judgment was entered on September 26, 1995. A petition for rehearing was denied on October 24, 1995. The jurisdiction of this Court is invoked under 28 U.S.C. § 1254(1).

STATUTORY PROVISIONS INVOLVED

35 U.S.C. § 111(a) provides in pertinent part:

> (1) *Written application.* -- An application for patent shall be made, or authorized to be made, by the inventor, except as otherwise provided in this title, in writing to the Commissioner.
>
> (2) *Contents.* -- Such application shall include -- (A) a specification as prescribed by section 112 of this title . . .

35 U.S.C. § 112 provides in pertinent part:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.
>
> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.
>
> * * * * * * *
>
> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure,

material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

35 U.S.C. § 251 provides in pertinent part:

> Whenever any patent is, through error without any deceptive intention, deemed wholly or partly inoperative or invalid, by reason of a defective specification or drawing, or by reason of the patentee claiming more or less than he had a right to claim in the patent, the Commissioner shall, on the surrender of such patent and the payment of the fee required by law, reissue the patent for the invention disclosed in the original patent, and in accordance with a new and amended application, for the unexpired part of the term of the original patent. No new matter shall be introduced into the application for reissue.
>
> * * * * * * *
>
> No reissued patent shall be granted enlarging the scope of the claims of the original patent unless applied for within two years from the grant of the original patent.

35 U.S.C. § 271 provides in pertinent part:

> (a) Except as otherwise provided in this title, whoever without authority makes, uses or sells any patented invention, within the United States during the term of the patent therefor, infringes the patent.

35 U.S.C. § 305 provides in pertinent part:

> In any reexamination proceeding under this chapter, the patent owner will be permitted to propose any amendment to his patent and a new claim or claims thereto . . . . No proposed amended or new claim enlarging the scope of a claim of the patent will be permitted in a reexamination proceeding under this chapter . . .

STATEMENT OF THE CASE

This case presents two important questions. First, whether an accused product can be deemed an infringement of a patent when the accused product is clearly not within the literal scope of any patent claim. In this case, the patent claims in issue require a nylon resin to have a ratio of two chemical units of between about 5:1 and 7:1, but the accused product has a ratio of only 4:1. Although the trial court explicitly held 4:1 was not "about 5:1," a panel of the United States Court of Appeals for the Federal Circuit, relying upon its sharply divided *en banc* decision in *Hilton Davis Chem. Co. v. Warner-Jenkinson Co.*, 62 F.3d 1512 (Fed. Cir. 1995) (for which a petition for certiorari is now pending), held that a product with a 4:1 ratio is "equivalent" to one with an about 5:1 ratio and thus infringes regardless of the claim limitations.

Second, this case presents the question of whether the appellate court, based on evidence that had been excluded at trial and that the accused infringer had no opportunity to rebut, can make findings and order that damages be recalculated upward. Based on such excluded evidence, the Federal Circuit ordered recalculation to increase the multimillion dollar damages award against a defendant who never had an opportunity to offer any evidence on the key damages issue.

1. Procedural History: Respondent Pall Corporation ("Pall") brought this lawsuit under 35 U.S.C. § 281 against Petitioner MSI, charging that MSI's nylon microfiltration membranes and method for making them infringed the

product and process claims of Pall's U.S. Patent No. 4,340,479 (the "Pall Patent"). Pet. App. 2a.[1]

A. The Court Agreed MSI's Product Does Not Fall Within The Literal Claim Scope. When the suit was filed, MSI's accused membranes were made with a material known as Nylon-66, which has a ratio of certain chemical units of 5:1. After the lawsuit began, MSI converted most of its accused product line to a chemically distinct nylon, Nylon-46, which has a ratio of 4:1, and which is not literally covered by the claims. Pet. App. 8a, 11a. During the liability trial, MSI contended that its Nylon-46 products did not infringe Pall's patent because they were made from Nylon-46, a material which not only was not literally covered by the claims, but also which MSI contended Pall had disclaimed during the prosecution of the application which resulted in issuance of the Pall patent. Pet. App. 11a, 12a.[2]

---

[1] Nylon "membranes" are thin sheet-like objects with very small "pores" which allow fluid to pass through the membrane, while retaining bacteria and other materials that are larger than the pores. Pet. App. 2a. One set of Pall's patent claims refers to a membrane made from any of three specific nylon polymers, the commercial names of which are Nylon-66, Nylon-610, and Nylon-6. Pet. App. 3a, 5a-6a. Another set of claims refers to nylons having a ratio of certain chemicals of 5:1 to 7:1. Pet. App. 8a.

[2] The district court found that because of the chemical differences between the claimed nylons and Nylon-46, Nylon-46 is *not* the type of nylon required by the invention of the patent-in-suit, because it is not one of the three named nylons and its 4:1 ratio falls outside the claimed range in the ratio claims. Pet. App. 8a, 11a. The ratio claims require "*a ratio* CH_2:NHCO of methylene CH_2 to amide NHCO groups within the range *of about 5:1 to about 7:1. . .*", and the district court found that the 4:1 ratio of Nylon-46 is *not* "about 5:1." Pet. App. 8a, 11a.

During prosecution of its patent application, Pall had narrowed its claims from covering all nylons (with no ratio range) to covering only those within a narrow range of chemical ratios. Pet. App. 12a.[3] At trial, although the district court agreed with MSI that none of the patent claims literally covered Nylon-46 products, it still found that MSI's products infringed the ratio claims under the doctrine of equivalents. Pet. App. 16a.

B. The Damages Award. The district court awarded Pall over $4 million in damages, including lost profits. *See* Pet. App. 110a. In deciding the amount of lost profits, a key issue before the district court was whether a third party's product that Pall had licensed in settlement also infringed the Pall patent. Pet. App. 20a-21a. The district court excluded all of Pall's evidence offered to prove infringement, and without making any findings on whether the third party's product actually met the patent claim limitations and thus infringed, ruled that the third party's product did not infringe solely on the basis that it was licensed. Pet. App. 21a, 100a. MSI then had no reason or opportunity to rebut the excluded evidence of infringement. Based on the license alone, the district court

---

[3] In remarks to the Patent Office adding the ratio claims, Pall stated that the new claims were directed to a narrow class of materials, i.e., "to provide basis for a *narrow* subclass of polyamide resins disclosed..." (Emphasis added). Pet. App. 54a, 115a. Pall also argued that "[t]he range of CH_2:NHCO ratios within the range from about 5:1 to about 7:1 is *actually rather narrow. . . These limits constrain a rather narrow range* of CH_2:NHCO ratios, and *clearly exclude the vast majority of polyamide resins. . .*" (Emphasis added). Pet. App. 156a, *see* 12a-13a. In response to these arguments, the Patent Office allowed the narrowed ratio claims. Pet. App. 55a.

then denied Pall lost profits damages for the entire period during which the third party's product was offered. *See* Pet. App. 21a.

After the district court stayed the injunction against MSI's Nylon-46 products pending appeal, MSI appealed the finding that its Nylon-46 product infringed, and both parties appealed the damages award. Pet. App. 2a, 24a. The Federal Circuit affirmed the liability decision, and reversed and remanded on damages. Pet. App. 16a, 22a. The court's remand ordered recalculation of damages, based purely on the assumption that the third party's product infringed, without having any evidence of record from MSI on the infringement issue. *See* Pet. App. 21a-22a. The Federal Circuit then denied MSI's petition for rehearing. Pet. App. 112a.

2. Similarities Between This Case And *Hilton Davis*. There are remarkable similarities between the facts of this case relating to the doctrine of equivalents and those of the *Hilton Davis* case, for which a petition for certiorari is now pending, *Warner Jenkinson Co. v. Hilton Davis Chem. Co.*, No. 95-728. Those similarities provide sufficient grounds to grant certiorari in this case and remand it to the Federal Circuit, should the Court decide to review the same important doctrine of equivalents issues raised in *Hilton Davis*.

Most importantly, this case, like *Hilton Davis,* involves the fundamental question of the scope of the doctrine of equivalents. Pet. App. 11a; *Hilton Davis*, 62 F.3d at 1516. This case and *Hilton Davis* also involve strikingly similar facts. Each involves a patent on membrane technology, with claims directed to certain narrow ranges of properties. In *Hilton Davis*, the patentee narrowed its claims during the

patent application process to require the use of a pH range of "from approximately 6.0 to 9.0." 62 F.3d at 1515-16. Similarly, in this case Pall narrowed its claims to require use of a nylon having a specific chemical ratio within a range of "about 5:1 to about 7:1." Pet. App. 12a-13a. In *Hilton Davis*, the court held that a process with a pH of 5.0 infringed even though the lower limit of the claim was "approximately 6.0," while the court in this case held that a ratio of 4:1 infringed even though the lower limit of the claim was "about 5:1." *See Hilton Davis*, 62 F.3d at 1524; Pet. App. 16a. In both *Hilton Davis* and this case, the court found infringement even though the accused processes and products were well below the claimed lower limit of the ranges of the respective patents.

In ruling against Petitioner MSI in this case, the Federal Circuit relied on *Hilton Davis*, which was a closely divided decision heard *en banc* in order "to consider the important issues raised concerning the doctrine of equivalents." *Hilton Davis*, 62 F.3d at 1516.[4] The court's struggle to resolve those issues in *Hilton Davis* produced wide disagreement in five separate opinions.[5] Recognizing the

---

[4] The court of appeals in *Hilton Davis* sought briefing on two key questions: "Does a finding of infringement under the doctrine of equivalents require anything in addition to proof of the facts that there are the same or substantially the same (a) function, (b) way, (c) result, the so-called triple identity test of *Graver Tank [& Manufacturing Co.] v. Linde Air Products Co.*, 339 U.S. 605 (1950), and cases relied on therein?. . . Is application of the doctrine of equivalents by the trial court to find infringement of the patentee's right to exclude, when there is no literal infringement of the claim, discretionary in accordance with the circumstances of the case?" 62 F.3d at 1516.

[5] Observing that this Court had "mapped the modern contours of the doctrine of equivalents in its landmark *Graver Tank* decision", *Hilton Davis*, 62 F.3d at 1517, the court concluded that the doctrine gave a

fundamental nature of the issues, Judge Newman's concurring opinion and several dissents suggested that it would be appropriate for the Supreme Court to review the doctrine of equivalents through that case. *Hilton Davis*, 62 F.3d at 1529 (Newman, J., concurring), 1545 (Plager, J., dissenting), and 1549 n.3 (Lourie, J., dissenting). Because these issues are recurring, and indeed because the same wrong committed in *Hilton Davis* is committed here, the circuit judges' suggestion for Supreme Court review is particularly ripe.

Judge Plager's dissent noted that the doctrine of equivalents "is regularly used by patentees to seek greater coverage for their patents than the patent statute grants," and argued that the doctrine "is a virtually uncontrolled and unreviewable license to juries to find infringement if they so choose." *Hilton Davis*, 62 F.3d at 1537, 1538 (Plager, J., dissenting). Judge Plager objected that the expansion of the patent "is done largely without regard to and independent of the express limitations of the patent claims which may have brought about their allowance by the [Patent Office] in the first place," *Hilton Davis*, 62 F.3d at 1538 (Plager, J., dissenting), and he found no basis for a doctrine broad enough to rescue patent holders from their own failure to claim all that they lawfully might have

---

patent holder the right to establish infringement whenever a fact finder determined that the differences between an accused product and the product claimed in the patent were "insubstantial." *See Hilton Davis*, 62 F.3d at 1521-22. As a result, "those who make only insubstantial changes to a patented product or process are liable for infringement, regardless of their awareness of the patent and its disclosure." *Hilton Davis*, 62 F.3d at 1520. The *Hilton Davis* court also held that although the patent applicant had narrowed its patent claims in order to win Patent Office approval, the doctrine of equivalents still would reach into the surrendered area. *See Hilton Davis*, 62 F.3d at 1525.

claimed -- "[t]he solution to the problem of inadequate or incomplete claim drafting is not arbitrary after-the-fact 'interpretation' under the guise of 'equivalents,' whether by judge or jury, that goes beyond anything in the claims themselves." *Hilton Davis*, 62 F.3d at 1541-42 (Plager, J., dissenting).

Judge Lourie's dissent challenged the majority's disregard of claim limitations, stating that "the substantiality of the differences [between the patented and accused processes] is still only one of the factors according to *Graver*, arguably the most important factor, which a court should consider in deciding whether to apply the [doctrine of equivalents]." *Hilton Davis*, 62 F.3d at 1547 (Lourie, J., dissenting). Noting that "[t]he whole purpose of the doctrine [of equivalents] is to defeat piracy and to do justice to a patentee," Judge Lourie said that "[i]ntent to misappropriate someone else's invention is the hallmark of a pirate, and intent must therefore not be excluded if a suitable judgment is to be made concerning the applicability of the [doctrine of equivalents]." *Hilton Davis*, 62 F.3d at 1548 (Lourie, J., dissenting). The majority, however, dismissed this theory, concluding that "[i]nfringement is, and should remain, a strict liability offense." *Hilton Davis*, 62 F.3d at 1527.

Finally, Judge Nies's dissent challenged the *Hilton Davis* majority's view that the patentee could reclaim under the doctrine of equivalents what it had surrendered before the Patent Office. Judge Nies pointed out that, "[i]n view of the liberality in current claiming practice, the need for the doctrine of equivalents because of difficulties in drafting claims to cover an invention in all possible forms is a rare case." *Hilton Davis*, 62 F.3d at 1560 (Nies, J., dissenting). Judge Nies reasoned that "[h]aving narrowed

the claim's range of pH to secure the Examiner's withdrawal of his prior rejection, [the patentee] may not now resort to the doctrine to cover equivalents thereof." *Hilton Davis*, 62 F.3d at 1582 (Nies, J., dissenting). Judge Nies also pointed out that a patentee could resort to the statutory reissue procedure of 35 U.S.C. §§ 251, 252 to seek protection beyond the patentee's own agreed to claim language in the original patent. Because the reissue statute allows competitors to invoke "intervening rights," however, Judge Nies noted that "[t]he patentee is much better off evading the reissue procedure which Congress had provided, and resorting to its counterpart, the doctrine of equivalents, created out of the judiciary's sense of 'fairness.'" *Hilton Davis,* 62 F.3d at 1560 (Nies, J., dissenting).

As in *Hilton Davis*, in the present case Pall narrowed its claims before the Patent Office to cover only a membrane prepared from a nylon resin having a chemical ratio "of about 5:1 to about 7:1." The Patent Act does not allow it to now stretch its claims to cover a membrane prepared from a resin having a 4:1 ratio.

REASONS FOR GRANTING THE WRIT

This Court should grant certiorari to decide a fundamental question of patent law in this case -- the scope of protection against patent infringement. *See* 35 U.S.C. § 271(a). Although the appeals court here relied on the recent *Hilton Davis* decision to conclude that MSI's product infringes, although it falls outside the terms of the plaintiff's patent claim, the court has violated the clearly expressed statutory policy of the Patent Act (i) requiring precise claiming to put the world on notice of the scope of protection (35 U.S.C. § 112); (ii) specifying "equivalents" protection only for a particular class of patents (35 U.S.C. § 112); (iii) requiring that reissue applications to broaden claims can only be filed within two years of patent grant (35 U.S.C. § 251); and (iv) requiring that claims broadened in reexamination be held invalid (*see* 35 U.S.C. § 305).

The *Hilton Davis* petition for certiorari establishes many sound reasons for Supreme Court review. Petitioner MSI here also raises additional arguments, namely that the Federal Circuit's ruling in this case warrants review because that ruling legitimizes after-the-fact enlargement of the scope of a patent claim, in direct contradiction to the Patent Act's statutory policy against enlarging claims in a patent reexamination. *See Quantum Corp. v. Rodime, PLC*, 65 F.3d 1577, 1584 (Fed. Cir. 1995) (claims enlarged during reexamination are invalid). Under the guise of the doctrine of equivalents, the circuit court now allows enlargement of a claim well beyond its literal terms, without invalidating the enlarged claim. Failing to grant certiorari in this case along with *Hilton Davis* allows the multimillion dollar judgment against MSI to threaten its existence, and subsequent review and reversal of *Hilton Davis* alone potentially would come too late to save it.

In addition, the Federal Circuit improperly resolved the damages issue on appeal despite the absence of necessary record evidence, exercising its power without consideration of its proper role in the judicial process. At the damages trial, Pall sought to prove it was entitled to lost profits damages, and attempted to introduce evidence relating to a third party product's infringement in order to demonstrate the absence of a non-infringing substitute. *See* Pet. App. 100a. The district court excluded that evidence and MSI therefore never had a reason or an opportunity to introduce rebuttal evidence. On appeal, the Federal Circuit reversed and remanded, ordering recalculation of damages based upon an assumed absence of non-infringing substitutes -- without *any* evidence that the third party's product infringed the patent and without allowing MSI an opportunity to introduce rebuttal evidence that the third party product did not infringe. In short, what the Federal Circuit did was rule based on what the plaintiff hoped its evidence might prove to the trial court, rather than based on what the evidence actually was. This case needs review to correct this improper exercise of judicial power, and remand to require district court inquiry into whether the third party products actually infringed, before damages can be substantially increased based on an assumption that remains unproven.

I. THE DOCTRINE OF EQUIVALENTS ISSUE PRESENTS A FUNDAMENTAL QUESTION OF PATENT LAW THAT REQUIRES SUPREME COURT RESOLUTION

The decision in this case is of extraordinary, widespread importance in the field of patent law. The recently filed

petition for certiorari in *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, No. 95-728 (Nov. 6, 1995), fully addresses most of the reasons that support granting certiorari in this case also, and those reasons are not repeated in detail here. Briefly, the Federal Circuit itself has recognized the significance of the issues presented, having ordered an *en banc* hearing in order "to consider the important issues raised concerning the doctrine of equivalents." *Hilton Davis*, 62 F.3d at 1516. In addition, one concurring opinion and two dissents in *Hilton Davis* recognized that the doctrine of equivalents is appropriate for this Court's review. *Hilton Davis*, 62 F.3d at 1529 (Newman, J., concurring), 1545 (Plager, J., dissenting), and 1549 n.3 (Lourie, J., dissenting).

The Federal Circuit's recent decisions in this case and *Hilton Davis* give broad protection against "substantial" "equivalents", and are inconsistent with the Patent Act. In addition to the reasons persuasively articulated in the *Hilton Davis* petition, the decisions violate the statutory policy embodied in the Patent Act. First, 35 U.S.C. § 112 requires that a patentee precisely draft its patent claims to put the world on notice of the scope of protection. Using the doctrine of equivalents to effectively expand claims beyond their written scope frustrates that statutory provision and defeats the purpose of the patent application process, which allows a patent applicant ample opportunities to obtain claims which adequately cover what the applicant believes to be the invention. Second, 35 U.S.C. § 112 also specifies that only one particular class of patents is to receive protection from "equivalents." Third, 35 U.S.C. § 251, on patent reissue proceedings, provides only a limited two year period in which to apply for claims broader than those in the original patent. Allowing

subsequent broadening through the doctrine of equivalents neutralizes that provision.

The absurdity of the Federal Circuit's expansive doctrine of equivalents is further shown by contrasting that court's recent treatment of a patent claim from a patent reexamination proceeding with the enlarged patent claim at issue here.[6] In *Quantum Corp. v. Rodime, PLC*, 65 F.3d 1577 (Fed. Cir. 1995), the patentee during reexamination added the word "approximately" to the phrase "at least 600" tracks per inch, to make the patent claim read "at least approximately 600" tracks per inch. *Quantum*, 65 F.3d at 1579. The Federal Circuit reviewed the reexamined claim against the language of section 305 and its policy, and held that adding the word "approximately" impermissibly *broadened* the claim, making it invalid and unenforceable. *Quantum*, 65 F.3d at 1582, 1584. In contrast, the Federal Circuit here followed an entirely different policy, and allowed the lower court to read "*about 5:1*" to mean "*4:1.*" Such a reading clearly broadens Pall's claim and permits enforcement of what in a reissue proceeding doubtless would be an invalid claim.

In addition, the decision here is at odds with another recent *en banc* Federal Circuit decision for which this Court has granted certiorari. In *Markman v. Westview Instr., Inc.*, 52 F.3d 967, 979 (Fed. Cir.) (*en banc*), *cert. granted*, 64

---

[6] In a reexamination proceeding, the Patent Office considers whether a prior art patent or printed publication has any bearing on the patentability of a claim or claims in an issued patent. 35 U.S.C. §§ 304-305. The Patent Act permits the patent owner in a reexamination to amend its claims to avoid the prior art, but in doing so the patent owner may not "enlarg[e] the scope of a claim. . ." 35 U.S.C. § 305. That policy against enlargement of claims is frustrated by the Federal Circuit's broad doctrine of equivalents.

U.S.L.W. 3238 (No. 95-26, granted Sept. 27, 1995), the Federal Circuit decided that interpreting claims to determine whether they are infringed is a question of law for the court. In contrast, in this case under the doctrine of equivalents, the Federal Circuit ruled that determining infringement is a question of fact. Pet. App. 11a; *see Hilton Davis*, 62 F. 3d at 1523. This inconsistent treatment of infringement provides no logical guidance for businesses legitimately seeking to market products free from claims of patent infringement.

Because the doctrine of equivalents is now being interpreted to permit patent holders to claim protections far beyond the terms of the patent itself, its definition will impact most if not all patent infringement lawsuits. The Federal Circuit's definition will promote great uncertainty about the scope of patent protection, which can be expected to spur additional patent litigation as patentees decide to pursue suits against defendants who have not literally infringed their patents, and will require the parties and courts to undertake extensive inquiry into whether "substantial differences" exist between the accused and patented products or processes. That definition also may adversely affect the ability of competitors to "design around" a claimed invention, which is "one of the important public benefits that justify awarding the patent owner exclusive rights to his invention." *Hilton Davis*, 62 F.3d at 1520. The uncertainty about the precise scope of the protected invention to be "designed around" created by a broad doctrine of equivalents inhibits a new inventor's ability and willingness to try to invent in the area of the patent.

As pointed out in the petition in *Hilton Davis*, it is not appropriate to leave the Federal Circuit to its own devices

in settling such an important question of patent law. The Federal Circuit itself plainly acknowledged that it did not feel empowered to solve the problems presented by the doctrine of equivalents -- instead, in this case and in *Hilton Davis* it invoked what it regarded as binding Supreme Court precedent, thus conceding that it was constrained to reach its interpretation of the doctrine of equivalents by this Court's *Graver Tank* decision and predecessor decisions. *See* Pet. App. 11a (citing *Graver Tank* as authority for "substantial difference" test); *Hilton Davis*, 62 F.3d at 1517-20 (*Graver Tank* established "substantiality of the differences" test, determined elements of "substantiality" inquiry, and determined factual character of "equivalents" question).

The dissents in *Hilton Davis* noted that authoritative resolution of the continuing force of *Graver Tank* and of the continuing role and contours of the doctrine of equivalents must come from this Court. *See Hilton Davis*, 62 F.3d at 1539 (Plager, J., dissenting) ("in today's opinion, the majority abdicates this responsibility [to address the problems caused by its readings of Supreme Court decisions], leaving to the Supreme Court the obligation of attending to the problem if it is to be attended to at all"). Judge Lourie bluntly stated that "in light of *Graver*, it may be that only the Supreme Court, writing without the confining strictures of *Graver*, can deal cleanly with this issue." *Hilton Davis*, 62 F.3d at 1549 n.3 (Lourie, J., dissenting).[7] In fact, a member of the majority concluded

---

[7] Judge Lourie pointed to "the greater complexity of today's patented high technology inventions compared with those made 50 or more years ago" as a reason for his conclusion that "*Graver* speaks to a time that is long past." *Hilton Davis*, 62 F.3d at 1549 n.3 (Lourie, J., dissenting).

that "any change in the legal and factual fundamentals so explicitly laid out by the Supreme Court is beyond our judicial authority." *Hilton Davis*, 62 F.3d at 1529 (Newman, J., concurring).

Clearly, the Federal Circuit's broad view of the doctrine of equivalents goes far beyond what the doctrine was intended to do, and stymies rational attempts at predicting what infringes and what does not. Accordingly, this case requires Supreme Court review.

II. IN INCREASING DAMAGES, THE FEDERAL CIRCUIT IGNORED THIS COURT'S PROHIBITION AGAINST RULING ON EVIDENCE NOT INTRODUCED AT TRIAL

This case also involves the important question of whether an appellate court may order that damages be recalculated below based on a theory for which there was *no* evidentiary support, because all evidence on that theory was excluded by the trial court, and the defendant therefore had no opportunity for rebuttal at trial. If the Federal Circuit's damages decision is allowed to stand, Petitioner MSI will be required to pay millions of dollars in additional damages when it has been denied the opportunity to offer evidence on the key damages issue.

At trial in this case, Respondent Pall sought to prove that it was entitled to lost profits damages, which required proof of an absence of noninfringing substitutes. Pet App. 20a. To meet that requirement, Pall sought to introduce evidence that a third party's product was infringing, but the district court excluded that evidence on the grounds that Pall licensed the third party's product pursuant to a

settlement agreement. Pet. App. 100a. Because the evidence on infringement was excluded, MSI never had an opportunity to introduce rebuttal evidence that the third party's product did not infringe. Accordingly, on appeal the trial record was insufficient to establish whether or not the third party's product actually met the Pall patent claim limitations and infringed the patent.

The Federal Circuit, however, ruled that the third party's product was in fact infringing, even though the trial court never considered any evidence on that issue. Pet. App. 21a. Clearly, the appellate court overstepped its role, which is not to make rulings on what one party expects or hopes the evidence will prove -- rather, the appellate court's role is to make rulings based on what the evidence *is*.

Allowing this damages decision to stand frustrates the requirement that appellate courts rule only on evidence introduced into the record. This Court has held that it is reversible error for an appeals court to rule upon evidence never introduced into the trial record. *See Singleton v. Wulff*, 428 U.S. 106, 120-21 (1976) (appellate court improperly ruled on merits against petitioner where petitioner had no opportunity to offer opposing evidence or argument below); *see also Ballard Medical Products v. Wright*, 821 F.2d 642, 643 (Fed. Cir. 1987) (appellate court may consider only record as made before district court). Because remanding for a recalculation of damages (rather than an inquiry into the nature of the evidence) was improper, this Court should grant certiorari on this issue also.

CONCLUSION

The Petition for a Writ Certiorari should be granted.

Dated: December 21, 1995

Respectfully submitted,

STEVEN M. BAUER
Counsel of Record
JOHN J. COTTER
TESTA, HURWITZ
& THIBEAULT
125 High Street
Boston, MA 02110
(617) 248-7000

Attorneys for Petitioner,
Micron Separations, Inc.

INDEX TO APPENDIX

A. Opinions of United States Court of Appeals for the Federal Circuit (September 26, 1995)..... 1a

B. Memorandum and Orders of United States District Court for the District of Massachusetts in Favor of Plaintiff and Against Defendant (May and June, 1991) ... 30a

C. Order of United States Court of Appeals for the Federal Circuit denying Petition for Rehearing (October 24, 1995)..... 112a

D. Judgment, United States Court of Appeals for the Federal Circuit (September 26, 1995)..... 113a

E. Excerpts from United States Patent and Trademark Office file history for United States Patent No. 4,340,479 ..... 114a

United States Court of Appeals for the Federal Circuit

91-1393, -1394, -1409

PALL CORPORATION,

Plaintiff/Cross-Appellant,

V.

MICRON SEPARATIONS, INC.,

Defendant-Appellant.

DECIDED: September 26, 1995

Before RICH, NEWMAN, and MAYER, Circuit Judges.

Opinion for the court filed by Circuit Judge NEWMAN. Separate opinion, concurring in the judgment, filed by Circuit Judge MAYER.

NEWMAN, Circuit Judge.

Both parties appeal aspects of the judgment of the United States District Court for the District of Massachusetts,[1] wherein Micron Separations, Inc. ("MSI") was adjudged to have infringed a patent owned by Pall Corporation ("Pall") relating to polyamide membranes that are used in microfiltration. We affirm the judgment of infringement, reverse as to willful infringement, modify the damages award, and remand for recalculation of damages.

Background

Microfiltration membranes have an extremely small pore size, and are used to remove unwanted microscopic substances such as bacteria from fluids, or to separate and retain desired microscopic substances such as antibodies. Microfiltration membranes are used, for example, by pharmaceutical companies in bacteria-free drug production, by electronics manufacturers to purify water for chip manufacture, by hospitals to filter contaminants from fluids that are administered to patients, in diagnostics to detect the presence of antibodies or antigens, and as transfer membranes for identification of genetic characteristics. A particularly useful pore size for microfiltration membranes is about 0.22 micron, for this pore size yields the highest flow rate consistent with retention of the 0.3 micron

---

[1] Pall Corp. v. Micron Separations, Inc., No. 86-1427-Y (D. Mass. June 24, 1991). On Nov. 5, 1993 the court decided to hear this case en banc in order to consider the questions set forth in the court's order of Jan 7, 1994. Having resolved those questions in the case of Markman v. Westview Instruments, Inc., 52 F.3d 967, 34 USPQ2d 1321 (Fed. Cir. 1995) (en banc), the case has been returned to the panel for disposition in accordance therewith.

Pseudomonas diminutia bacteria; removal of these bacteria is the standard criterion for sterilization by microfiltration.

Microfiltration membranes are not new, although membranes of the prior art were generally subject to deficiencies such as brittleness, excessive shrinkage, poor solvent resistance, limited flow rate, excessive clogging, and limited sterilizing ability. Microfiltration membranes had previously been made from organic polymers, but those membranes generally required the use of wetting agents for filtration, for water does not flow well through microporous membranes that are not instantly wettable. The addition of wetting agents to facilitate flow is undesirable because it adds impurities to the system.

In accordance with United States Patent No. 4,340,479, invention of Dr. David B. Pall ("the Pall patent"), microfiltration membranes are made from organic polymers called polyamides. The particular polyamides of this invention are sometimes called "nylons," the generic term for linear aliphatic polyamides. The polyamide membranes at issue were made from the commercially available polymers nylon 66 and nylon 46.[2] The method of making these membranes and the membranes themselves are described in the Pall patent and in the district court's opinion, and will be repeated only as necessary to explain our decision.

---

[2] In this common nomenclature for nylon polyamides, integers signify the number of carbon atoms in the monomers from which the polymer is made. For example, in nylon 66 the first 6 represents the number of carbon atoms derived from the diamine monomer, and the second 6 represents the number of carbon atom in the diacid monomer. Nylon 46 has 4 carbon atoms in the diamine and 6 carbon atoms in the diacid.

Membranes had been made of polyamides before Dr. Pall's invention, but the prior membranes were either soluble in alcohol or required the use of wetting agents for efficient filtration. The membranes of the prior art also had a surface skin of reduced porosity that retarded wettability of the membrane material and increased the flow time. The Pall patented membranes are naturally and instantaneously wettable and alcohol-insoluble, with uniform pore size throughout the membrane. They achieve efficient flow without the use of wetting agents. The Pall membranes, due to their improved properties and increased effectiveness in microfiltration, achieved not only commercial success but also scientific recognition. The trial court found:

> Dr. Pall and his associates were pioneers both in the invention, development, and commercialization of functional nylon microfiltration membranes and in the theory of microfiltration.

The Pall microfiltration membranes were made of nylon 66, and were introduced into commerce in 1978. The Pall patent issued in 1982. In 1983 MSI introduced a microfiltration membrane made of nylon 66. Pall filed suit in 1986. In 1989 MSI converted most but not all of its nylon 66 membrane production to nylon 46. The case came to trial in 1991.

The district court held that the Pall patent was valid, that MSI's nylon 66 membranes literally infringed the patent's product claims, that MSI's nylon 46 membranes infringed the product claims under the doctrine of equivalents, and that MSI's process for producing the nylon membranes infringed the patent's process claims under the doctrine of equivalents. The court held that MSI's

infringement was willful to the limited extent of MSI's continued manufacture of some nylon 66 membranes after it had shifted most of its production to nylon 46. Although MSI declared bankruptcy after the adverse district court judgment,[3] it remains operating under a stay of injunction granted by the district court as to MSI's nylon 46 membranes.[4]

MSI appeals the rulings of infringement and willful infringement. Pall cross-appeals aspects of the damage award.

INFRINGEMENT

Nylon 66 Membranes

A representative product claim of the Pall patent is:

> 34. A hydrophilic skinless alcohol-insoluble polyamide resin membrane sheet of alcohol-insoluble hydrophobic polyamide resin selected from the group consisting of polyhexamethylene adipamide, polyhexamethylene sebacate, and poly-ε-caprolactam, and capable when completely immersed in water of being wetted through within no more than one second, and reverting when heated to a temperature just

---

[3] In re Micron Separations, Inc., No. 91-41885-JFQ (Bankr. D. Mass.).

[4] Pall Corp. v. Micron Separations, Inc., No. 86-1427-Y, slip op. at 1.

below the softening temperature of the membrane to a hydrophobic material which is no longer wetted by water.

Nylon 66 is polyhexamethylene adipamide, named in claim 34. It was not disputed that all of the limitations of claim 34 were met by MSI's nylon 66 membranes, except for the term "skinless," the meaning of which received extensive attention at trial. MSI argued that the plain meaning of "skinless" eliminated the MSI products from infringement, because a photomicrograph showed a "skin" on the MSI membranes. Pall's position was that "skinless" as used in the specification and claims should be understood as a performance characteristic, for a skin is a nonporous layer that impedes filtration.

Claim interpretation is a question of law Markman v. Westview Instruments, Inc., 52 F.3d 967, 34 USPQ2d 1321 (Fed Cir. 1995) (en banc). We review the construction of the claims without deference to that of the district court. Id. at 979, 34 USPQ2d at 1329 ("Because claim construction is a matter of law, the construction given the claims is reviewed de novo on appeal.") In construing the claims we look to the language of the claims, the specification, and the prosecution history. Id. Extrinsic evidence may also be considered, if needed to assist in determining the meaning or scope of technical terms in the claims. Id. at 980, 34 USPQ2d at 1330.

At trial both sides presented support for their conflicting positions concerning the term "skinless." Pall presented data showing "bubble point," "flow time," and "KL curve" measurements of the membranes in suit. These measurements were described in the Pall patent specification as tests for determining the presence or absence of a skin on a membrane. The bubble point test measures the pressure applied to a membrane whose pores

are filled with water in order to force the water through the pores; the larger the bubble point value, the smaller the pores in the membrane. Flow time is the time required for a certain amount of water to pass through a given area of membrane; the smaller the pores the longer the flow time. The KL curve depicts the flow of water through a membrane at constant pressure; skinless membranes characteristically show an initially level KL curve followed by a sharp rise in the curve as flow commences, whereas KL curves for skinned membranes show a gradual upward-sloping curve. These are generally accepted tests of whether a membrane is skinned or skinless, for a non-porous skin impedes the passage of water through the membrane, and is detected by all three tests. The district court defined "skinless" as a performance characteristic in accordance with the parameters of these tests. We too conclude, based on the specification and the data in evidence, that "skinless" is properly construed as a performance characteristic, and that a surface that does not impede flow is "skinless" as that term is used in the art of filtration membranes.

The district court then applied the construed claims to MSI's membranes. The court found that the MSI membranes had bubble points, flow times, and KL curves characteristic of skinless membranes. The court also observed that MSI's product literature described its membranes as of uniform pore size or having precise porosity, which the court found were necessary characteristics of skinless membranes. The court thus found, on the totality of the evidence, that the MSI membranes did not have a barrier layer that blocked fluid flow, and that the MSI membranes were skinless as the Pall patent used that term. We discern no clear error in this finding.

Literal infringement is found when every limitation of a claim is met in the accused structure. Applying its interpretation of the term "skinless," which we have confirmed, the district court found that the MSI nylon 66 membranes literally infringed the Pall patent. The judgment of infringement by MSI's nylon 66 membranes is affirmed.

Nylon 46 Membranes

Three years after Pall filed this suit, MSI converted most of its membrane manufacture from nylon 66 to nylon 46. Nylon 46 is made not from hexamethylenediamine and adipic acid, but from tetramethylenediamine and adipic acid. Claim 34, quoted supra, does not name polytetramethylene adipamide (nylon 46). However, claim 116 of the Pall patent describes the polyamide resins in terms of their methylene to amide ratio:

> 116. A hydrophilic skinless alcohol-insoluble polyamide resin membrane sheet of alcohol-insoluble hydrophobic polyamide resin having a ratio CH_2:NHCO of methylene CH. to amide NHCO groups within the range of about 5:1 to about 7:1; capable when completely immersed in water of being wetted through within no more than one second, and reverting when heated to a temperature just below the softening temperature of the membrane to a hydrophobic material which is no longer wetted by water. [Emphasis added.]

Nylon 66 has a ratio of methylene to amide groups of 5:1. Nylon 46 has a ratio of 4:1. Pall asserts that the

term "about 5:1 to about 7:1 " is infringed by the ratio of 4:1, either literally or by the doctrine of equivalents.

A. Literal Infringement

The district court, construing the term "about 5:1 to about 7:1," observed that the word "about" does not have a universal meaning in patent claims, and that the meaning depends on the technological facts of the particular case. We have so held. E.g., Andrew Corp. v. Gabriel Electronics, Inc., 847 F.2d 819, 821-22, 6 USPQ2d 2010, 2013 (Fed. Cir.), cert. denied, 488 U.S. 927 (1988); W.L. Gore & Assoc. Inc. v. Garlock, Inc., 842 F.2d 1275, 1280, 6 USPQ2d 1277, 1282 (Fed. Cir. 1988).

The determination of whether the literal meaning or scope of "about 5:1 to about 7:1" includes 4:1 is a matter of claim construction, a question of law for decision de novo by this court. The use of the word "about," avoids a strict numerical boundary to the specified parameter. Its range must be interpreted in its technologic and stylistic context. We thus consider how the term "about 5:1 to about 7:1" was used in the patent specification, the prosecution history, and other claims. It is appropriate to consider the effects of varying that parameter, for the inventor's intended meaning is relevant. Extrinsic evidence of meaning and usage in the art may be helpful in determining the criticality of the parameter, and may be received from the inventor and others skilled in the field of the invention. See Markman, 52 F.3d at 980, 34 USPQ2d at 1330 ("The court may, in its discretion, receive extrinsic evidence in order to aid the court in coming to a correct conclusion' as to the 'true meaning of the language employed' in the patent.") (quoting Seymour v. Osborne, 78 U.S. (11 Wall.) 516, 546, (1871)).

Dr. Pall, the inventor, explained his usage of "about 5:1 to about 7:1 " as deriving from his tests of the performance of various nylon resin membranes. He explained that the ratios change in half integers, e. g., 7:1, 6.5:1, 6:1, etc., depending on the total number of methylene groups in the acid and amine components of the polymer. For example, each recurring unit of nylon 66 contains 10 methylene groups and 2 amide groups, for a ratio of 10:2, which reduces to 5:1. Each recurring unit of nylon 46 contains 8 methylene groups and 2 amide groups, for a ratio of 4:1. The Pall patent also illustrated a mixture having the ratio of 5.3:1.

Dr. Pall testified that he conducted experiments with several commercially available nylon resins. He found that a nylon resin having a methylene:amide ratio higher than 7:1 produced membranes that were less readily wettable, such that use of a wetting agent was required for optimum results. He therefore placed the upper limit of "about 7:1 " in the claims. Dr. Pall stated that the only commercially available nylon resin with a ratio lower than 5:1 was a nylon with the ratio of 3:1, and that he made a membrane of the 3:1 nylon and found it to be soluble in alcohol and therefore unacceptable. No experiments were conducted with a nylon between 3:1 and 5:1, he testified, because none was commercially available. He placed the lower limit at "about 5:1." The reasons for these claim limitations also appear in the patent specification.

The district court found that Dr. Pall's use of the word "about" was "appropriate." We agree that the evidence showed that an exact limitation would have been inappropriate. However, the evidence showed that while a ratio of 7:1 was satisfactory, higher ratios were not, suggesting that the upper limit was close to 7:1, and did not extend to, for example, 8:1. At the lower ratios, although Dr. Pall conducted no tests with resins between 3:1 and 5:1,

the 3:1 resin was clearly unsatisfactory. Reviewing all the evidence, the district court held that a literal reading of "about 5:1 to about 7:1" did not include the ratio of 4:1. On plenary review we reach the same conclusion.

Since the claim is construed more narrowly than would literally encompass the ratio of 4:1, the district court's finding that MSI's nylon 46 membranes do not literally infringe the Pall patent is affirmed.

B. Infringement by Equivalents

When literal infringement is not established, infringement may be proved under the doctrine of equivalents when there is not a substantial difference between the claimed invention and the accused product. Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 85 USPQ 328 (1950); Hilton Davis Chemical Co. v. Warner-Jenkinson Co., __ F.3d __, 35 USPQ2d 1641 (Fed. Cir. 1995) (en banc). The determination of whether the accused product is substantially the same as the claimed invention is a question of fact, and the district court's determination thereof is reviewed for clear error. Id. at __, 35 USPQ2d at __.

The district court found that MSI's nylon 46 membranes had substantially the same chemical and physical structure, performed the same function in the same way, and achieved the same result, as Pall's claimed membranes. The court thus found that claim 116 was infringed under the doctrine of equivalents.

MSI does not argue on this appeal that the nylon 46 and nylon 66 membranes are not equivalent. Instead, MSI argues that Pall is estopped to establish infringement based on equivalency because during patent prosecution Pall voluntarily gave up claim scope that would have literally included nylon 46. MSI asserts that Pall is estopped from

obtaining that scope under the doctrine of equivalents, even if the products are in fact equivalent.

Prosecution history estoppel limits infringement by otherwise equivalent structures, by barring recapture by the patentee of scope that was surrendered in order to obtain allowance of the claims. Mannesmann Demag Corp. v. Engineered Metal Products Co., 793 F.2d 1279, 1285, 230 USPQ 45, 48 (Fed. Cir. 1986); Thomas and Betts Corp. v. Litton Sys., Inc., 720 F.2d 1572, 1579, 220 USPQ 1, 6 (Fed. Cir. 1983). Thus, by actions taken during patent prosecution the patentee can be estopped from reaching subject matter that otherwise meets the criteria of equivalency.

Pall states that there is no estoppel with respect to nylon 46, because no claim scope covering nylon 46 was yielded due to prior art or based on any requirement of patent examination. We outline the circumstances: Pall's initial patent application contained broad claims, wherein the only limit placed on the nylon polyamide resin was that it be insoluble in alcohol. These claims stated no upper or lower limit to the methylene:amide ratio. Dr. Pall testified that upon continuing his research while his patent application was pending, he discovered that his view of the nylon resins usable in his invention was too broad. He eventually refiled the patent application with additional data, and claims to nylon resins "within the range of about 5:1 to about 7:1." Dr. Pall stated, and the prosecution record is in accord, that the refiling was based not on prior art or any requirement by the patent examiner, but on his own research.

The examiner for the continuation-in-part application at first rejected the new ratio claims under 35 U.S.C. §112, stating that the claimed range was too broad and unsupported by the disclosure. No prior art was cited. Dr. Pall responded that the claimed range was "actually

rather narrow" and that the claims "clearly exclude the vast majority of polyamide resins." MSI relies on this statement as the basis of estoppel. MSI states that whether polyamide resins having a ratio below about 5:1 were required by the examiner to be surrendered, or were voluntarily not claimed by Pall, resins having a 4:1 ratio are excluded by estoppel because of this response to the examiner. Pall states that "about 5: 1" was simply descriptive of the inventor's knowledge at the time the continuation-in-part application was filed, and that there is no estoppel against the admittedly equivalent 4:1 resin.

Prosecution history estoppel normally arises when a change of claim scope is made in order to overcome an examiner's rejection based on prior art. Estoppel may arise whether the change is made by amendment of the claims during prosecution, or by refiling the patent application with changed claims. Thus a patentee is estopped from recovering through equivalency that which was deemed unpatentable in view of the prior art. However, when a rejection based on prior art did not dictate the claim change that was made, it is necessary to look at the specific change and the reason, in ascertaining whether an estoppel has arisen by virtue of the change. Diversitech Corp. v. Century Steps, Inc., 850 F.2d 675, 681, 7 USPQ2d 1315, 1320 (Fed. Cir. 1988). See Bayer Aktienizesellschaft v. Duphar Int'l Research B.V., 738 F.2d 1237, 1243, 222 USPQ 649, 653 (Fed. Cir. 1984) ("a close examination must be made as to not only what was surrendered, but also the reason for such a surrender"); Hughes Aircraft Co. v. United States, 717 F.2d 1351, 1363, 219 USPQ 473, 481 (Fed. Cir. 1983) (an amendment to a claim may "have a limiting effect within a spectrum ranging from great to small to zero"). We take note that in the course of patent examination claims are often amended and rewritten and added and subtracted. A non-substantive change or a

change that did not in fact determine patentability does not create an estoppel. Laitram Corp. v. NEC Corp., 952 F.2d 1357, 1361, 21 USPQ2d 1276, 1279 (Fed. Cir. 1991).

The estoppel asserted by MSI arose not from prior art but from Pall's statement to the examiner, in response to the rejection that the claims were too broad and unsupported by the disclosure, that the claims were "actually rather narrow." There were no changes made in the claims in response to this rejection. A rejection for lack of support in the specification is deemed a rejection under 35 U.S.C. §112, first paragraph. In re Borkowski, 422 F.2d 904, 909, 164 USPQ 642, 646 (CCPA 1970). Section 112, first paragraph, states in part:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, to make and use the same . . . .

Whether amendment or argument made in response to a rejection under §112 produces an estoppel, as does an amendment made to obtain allowance in view of cited references, is dependent on the particular facts. There is no all-encompassing rule that estoppel results from all claim changes, or all arguments, whatever their cause or purpose. Laitram v. NEC, 952 F.2d at 1361, 21 USPQ2d at 1280; Hi-Life Products, Inc. v. American National WaterMattress Corp., 842 F.2d 323, 325, 6 USPQ2d 1132, 1134 (Fed. Cir. 1988).

As we have observed, a concession made or position taken to establish patentability in view of prior art on which the examiner has relied, is a substantive position

on the technology for which a patent is sought, and will generally generate an estoppel. In contrast, when claim changes or arguments are made in order to more particularly point out the applicant's invention, the purpose is to impart precision, not to overcome prior art. Such prosecution is not presumed to raise an estoppel, but is reviewed on its facts, with the guidance of precedent. See, e.g., Sun Studs, Inc. v. ATA Equipment Leasing, Inc., 872 F.2d 978, 990, 10 USPQ2d 1338, 1348 (Fed. Cir. 1989) (rejection for lack of enablement, withdrawn based on the patentee's arguments did not serve as a basis for estoppel "in these events"); Moeller v. Ionetics, Inc., 794 . F.2d 653, 659-60, 229 USPQ 992, 996-97 (Fed. Cir. 1986) ("on this record" prosecution history estoppel not applicable to amendment to more particularly point out the invention); Mannesmann Demag, 793 F.2d at 1285, 230 USPQ at 48 (estoppel not necessarily created, by an amendment designed only to remove a §112 indefiniteness rejection); Catepillar Tractor Co. v. Berco, S.p.A., 714 F.2d 1110, 1115, 219 USPQ 185, 187-88 (Fed. Cir. 1983) (prosecution history estoppel not found where rejection based on indefiniteness under 1 12, since prior art did not dictate the limitation at issue).

MSI argues that even if prosecution history estoppel does not limit Pall's claims to precisely the 5:1 to 7:1 range, the doctrine of equivalents can be invoked only for subject matter that is disclosed and enabled in the patent specification but not claimed. That is incorrect. The doctrine serves to guard against "fraud on a patent," Graver Tank, 339 U.S. at 608, 85 USPQ at 330, by enabling fair protection of the patentee's contribution. It is not controlling whether the inventor foresaw and described this potential equivalent at the time the patent application was filed. See, e.g., Atlas Powder Co. v. E.I. du Pont de

Nemours & Co., 750 F.2d 1569, 1581, 224 USPQ 409, 417 (Fed. Cir. 1984).

The district court applied these principles. The court found that Pall had not surrendered or abandoned patent protection outside of the 5:1 to 7:1 range, and that Pall's voluntary restriction of the claims in the continuation-in-part application, and the response to the examiner's rejection under §112, did not produce an estoppel with respect to the 4:1 product. The court found that although nylon 46 had been known chemically since 1942, nylon 46 was not commercially available at the time of Dr. Pall's invention. The court stated: "I do not find that nylon 46 was known in the sense that there was any requirement that Pall experiment with nylon 46 to understand its properties." Observing the close similarity in chemical structure and the identity of function, way, and result to the claimed membranes, the district court found infringement by MSI's nylon 46 membranes under the doctrine of equivalents.

We discern no reversible error in the application of the law of estoppel to the facts of this case, or in the court's finding that the nylon 46 membranes infringed under the doctrine of equivalents. The judgment of infringement is affirmed.

The Process Claims

In view of our affirmance of infringement of the product claims for the nylon 66 and nylon 46 membranes, we need not reach the process claims. A patent is infringed if any claim is infringed, Intervet America, Inc. v. Kee-Vet Lab., Inc., 887 F.2d 1 050, 1055, 12 USPQ2d 1474, 1477-78 (Fed. Cir. 1989), for each claim is a separate statement of the patented invention. 35 U.S.C. 282; Jones v. Hardy, 727 F.2d 1524, 1528, 220 USPQ 1021, 1024 (Fed. Cir. 1984).

Willfulness

In the context of patent infringement, a distinction is drawn between infringement that is not deemed "willful" because the accused infringer had a reasonable basis for believing that its actions did not infringe the patent, and infringement that deliberately disregarded the property rights of the patentee. See Stickle v. Heublein, Inc., 716 F.2d 1550, 1565, 219 USPQ 377, 388 (Fed. Cir. 1983).

Willfulness of infringement is a question of fact, for it includes elements of intent, reasonableness, and belief. See Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1250, 9 USPQ2d 1913, 1932 (Fed. Cir. 1988); King Instrument Corp. v. Otari Corp., 767 F.2d 853, 867, 226 USPQ 402, 412 (Fed. Cir. 1985); Underwater Devices, Inc. v. Morrison-Knudsen Co., 717 F.2d 1380, 1390, 219 USPQ 569, 576-77 (Fed. Cir. 1983). The boundary between unintentional and culpable acts is not always bright, see Rite-Hite Corp. v. Kelley Co., 819 F.2d 1120, 1125-26, 2 USPQ2d 1915, 1919 (Fed. Cir. 1987), for the facts often include subjective as well as objective elements. Thus willful infringement must be established by clear and convincing evidence, E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co., 849 F.2d 1430, 1440, 7 USPQ2d 1129, 1137 (Fed. Cir.), cert. denied, 488 U.S. 986 (1988), for it is a punitive finding, and can have the consequence of multiplication of damages.

The district court found that MSI's infringement was not willful at its inception and for several years thereafter. The court found that although MSI failed to obtain an infringement opinion of counsel before producing its nylon 66 membranes. MSI made "significant efforts to avoid the claims of the patent." Thus the district court found that MSI's infringing production of nylon 66 membranes from 1983 until October 1989 was not willful.

The court also found that MSI's production of nylon 46 membranes after October 1989 did not constitute willful infringement. Pall does not appeal these findings.

In October 1989 MSI shifted most of its production to nylon 46 membranes. However, MSI continued to manufacture some membranes using nylon 66. The district court referred to MSI's shift to nylon 46 as evidence that MSI knew that it had an alternative to its nylon 66 product, and found that MSI should have known by that time that its nylon 66 product infringed the Pall patent. The court stated that it assumed that MSI had acquired competent patent counsel, after three years of litigation. On these grounds the district court found that MSI's failure to shift to nylon 46 for all of its production showed the requisite culpability to sustain willfulness, from that time forward, with respect to MSI's continuing nylon 66 membrane production. The court doubled the damages for MSI's infringing sales of nylon 66 after October 1989. MSI appeals these rulings.

MSI argues that the district court violated Federal Rule of Evidence 407 in finding that MSI's continued production of nylon 66 membranes after MSI switched to nylon 46, was willful infringement. Rule 407 bars evidence of subsequent remedial action in proving culpability for a prior act or event.[5] The policy implemented by Rule 407 is

---

[5] **Rule 407.** When, after an event, measures are taken which, if taken previously, would have made the event less likely to occur, evidence of the subsequent measures is not admissible to prove negligence or culpable conduct in connection with the event. This rule does not require the exclusion of evidence of subsequent measures when offered for another purpose, such as proving ownership, control, or feasibility of precautionary measures, if controverted, or impeachment.

to avoid inhibiting post-accident repair, lest additional injury occur. Herndon v. Seven Bar Flying Service, Inc., 716 F.2d 1322, 1327 (10th Cir. 1983), cert. denied, 466 U.S. 958 (1984). Here MSI's conversion to nylon 46 was not relied on as evidence of culpability for the prior infringement by nylon 66 membranes, and the court declined to find willfulness for that prior infringement. Thus by its terms Rule 407 was not violated.

However, patent infringement is a continuing tort, and an action even if innocently begun does not automatically retain its purity as circumstances change. The filing of a lawsuit does not stop the clock insofar as culpability may arise from continuing disregard of the legal rights of the patentee. The district court relied on the fact that MSI switched to an alternative product three years into the litigation, yet continued to produce some of the nylon 66 membranes.

Willfulness of infringement after October 1989 is determined on the totality of the evidence. We do not hold that because the infringement was found not to be willful when begun, there is a greater burden on the patentee to prove willfulness as circumstances change. The requirement of law-abiding respect for the property of others is not reduced simply because lesser transgressions were overlooked. However, upon the ruling that willfulness was not established for MSI's activities during the initial six years of infringement, the partial conversion to the nylon 46 product while continuing some of the nylon 66 production is not probative of willfulness for the nylon 66 continuing production. Attempts to avoid or mitigate infringement, whether or not successful, do not of themselves enlarge the culpability of the continuing activity.

The finding of willful infringement for the continuing production of nylon 66 is clearly in error.

Absent other grounds for the finding of willfulness, this ruling and the award of damages attributed thereto are reversed.

DAMAGES

A

The district court awarded damages measured by Pall's lost profits on 25% of MSI's infringing sales, and a royalty of 8% on the remaining 75% of MSI's infringing sales. The district court relied on the presence in the marketplace of nylon membranes sold by Cuno Corporation, with whom Pall had settled worldwide litigation with respect to the patent here in suit and several Cuno patents, each having charged the other with infringement. Pall states that it is entitled to lost profits on all of MSI's infringing sales, at least until May 9, 1990, when Pall granted immunity to Cuno under the Pall patent.

In order to recover lost profits damages the patentee "must show a reasonable probability that, 'but for' the infringement, it would have made the sales that were made by the infringer." Rite-Hite Corp. v. Kelley Co., 56 F.3d 1538, 1545, 35 USPQ2d 1065, 1069 (Fed. Cir. 1995) (en banc); Yarway Corp. v. Eur-Control USA, Inc., 775 F.2d 268, 275, 227 USPQ 352, 357 (Fed. Cir. 1985); Kiniz Instrument, 767 F.2d at 863, 226 USPQ at 409. In a market with only two suppliers, the patentee and the infringer, this requirement is readily met, for example by applying the guideline set forth in Panduit Corp. v. Stahlin Bros. Fibre Works, Inc., 575 F.2d 1152, 1156, 197 USPQ 726, 730 (6th Cir. 1978). To establish lost profits by applying the evidentiary guideline of Panduit the patentee must show (1) that there was a demand for the patented product, (2) the absence of acceptable noninfringing substitutes, (3) that the

patentee was capable of meeting the demand, and (4) the amount of profits lost. This guideline facilitates the determination of damages by stating conditions which allow the inference that the patentee would reasonably have made the infringer's sales. See Del Mar Avionics, Inc. v. Quinton Instrument Co., 836 F.2d 1320, 1327, 5 USPQ2d 1255, 1260 (Fed. Cir. 1987).

The district court, applying this guideline, held that the Cuno membranes were "acceptable noninfringing substitutes" for the Pall membranes. Pall states that this is incorrect, that the Cuno membranes were the subject of ongoing infringement litigation until May 1990, when they were licensed. The district court should have recognized the distinction between the legal and market situation before and after the licensing of the Cuno products. During the period before the Cuno products were licensed their presence in the marketplace did not defeat Pall's entitlement to lost profits damages for all of MSI's infringing sales, for the Cuno products were not "noninfringing substitutes."

It was not necessary for Pall to continue the Cuno litigation to judicial decision of the issue of infringement, as MSI argues. The voluntary settlement of litigation does not retrospectively transform an accused infringing product into a "noninfringing substitute." See State Indus., Inc. v. Mor-Flo Indus., Inc., 883 F.2d 1573, 1578, 12 USPQ2d 1026, 1029 (Fed. Cir. 1989) (if the other suppliers "were likely infringers," State would have been entitled to their shares of the market in determining damages based on lost sales), cert. denied, 493 U.S. 1022 (1990); Micro Motion, Inc. v. Kane Steel Co., 894 F.2d 1318, 1322, 13 USPQ2d 1696, 1699 (Fed. Cir. 1990) (there is precedent for finding causation for lost profits damages if the alternative source of supply is an infringer); Datascope Corp. v. SMEC, Inc., 879 F.2d 820, 824-25, 11 USPQ2d 1321, 1323-24 (Fed. Cir. 1989) (the finding that there was an acceptable

noninfringing alternative can not be supported by the ongoing litigation between Datascope and a third party), cert. denied, 493 U.S. 1024 (1990).

However, after Pall settled with Cuno, the district court correctly held that Cuno's presence in the marketplace could not be ignored, and limited the award of lost profits to the share of MSI's sales that Pall would reasonably have made. For the remaining share the court viewed Pall as a hypothetical willing licensor, and accordingly assessed damages as an 8% royalty. This holding implements the reasoning that the purpose of compensatory damages is not to punish the infringer, but to make the patentee whole. See Aro Mfg. Co. v. Convertible Top Replacement Co., 377 U.S. 476, 507, 141 USPQ 681, 694 (1964) (the question to be asked is "'Had the infringer not infringed, what would the patent holder . . . have made?"); State Industries, 883 F.2d at 1577, 12 USPQ2d at 1028 (damages shall compensate the patentee for its pecuniary loss because of the infringement). Pall argues that this result provides a windfall to the infringer, for when there are multiple infringers the infringement will be profitable to the remaining infringers as soon as the patentee settles with any one of them. We doubt that injustice is inevitable, for the setting of the royalty rate and the discretion to multiply damages can assist in achieving a just remedy.

In summary, for MSI's sales after Pall settled with Cuno, we affirm the damages award based on recovery of Pall's lost profits for 25% of MSI's infringing sales, and a royalty of 8% for the remaining 75% of MSI's infringing sales. For the period before the grant of immunity to Cuno, Pall shall recover damages measured as its lost profits for all of MSI's infringing sales. We remand for the recalculation of damages.

B

The district court selected 45% as the rate of Pall's lost profits. MSI does not challenge this rate on appeal. However, Pall appeals this determination, stating that the court selected an arbitrary rate that was lower than the actual rate that Pall had proved.

Among its reasons for reducing the rate from that presented by Pall's accountants, the district court considered that MSI's prices were lower than Pall's, concluded that some of MSI's customers would have shifted to membranes other than nylon, and factored this into its reduction of Pall's estimated profits. Pall disputes the presence as well as the significance of asserted price differentials, and challenges the other premises of the district court's decision.

In general, an infringer's sales at a lower price do not defeat the patentee's recovery of its losses at the patentee's price, for the principle of patent damages is to return the patentee to the pecuniary position it would have been in but for the infringement. Aro Manufacturing, 377 U.S. at 507, 141 USPQ at 694. See also Rite-Hite, 56 F.3d at 1544, 35 USPQ2d at 1068 ("The statute thus mandates that a claimant receive damages 'adequate' to compensate for infringement.") However, in view of the complex of financial factors presented at trial, we discern no clear error in the district court's finding of the rate of Pall's lost profits. The district court's ruling on this aspect is affirmed.

Motions

MSI moves to strike the opinion of the district court that was written on April 14, 1992. That opinion was an edited form of the court's prior opinion from the bench, the district court having reserved the right to present a written

opinion. Although MSI objected to Pall's proposed substitute opinion, and to the transmittal to this court of a "substitute opinion, of any kind," it made no objection to that opinion after it was forwarded by the district court and did not move to strike it until two years after the district court's edited opinion was issued. MSI offers no explanation for the delay. The motion is denied.

Pall in turn states that the court should strike MSI's argument on the merits, raised in MSI's motion to strike the opinion of the district court. In view of our disposition herein, the motion is dismissed as moot.

Injunction

The stay of injunction pending appeal is vacated.

Costs

Each party shall bear its costs.

AFFIRMED IN PART, REVERSED IN PART,
MODIFIED IN PART
AND REMANDED. STAY VACATED.

United States Court of Appeals for the Federal Circuit

91-1393, -1394, -1409

PALL CORPORATION,

Plaintiff/Cross-Appellant,

V.

MICRON SEPARATIONS, INC.,

Defendant-Appellant.

MAYER, Circuit Judge, concurring in the judgment.

Claim interpretation demands an objective inquiry into how one of ordinary skill in the relevant art at the time of the invention would comprehend the disputed word or phrase in view of the patent claims, specification, and prosecution history. A patent, however, is written for a person of ordinary skill in an art; it is not written for a court. Because it is beyond argument that "[a] judge is not usually a person conversant in the particular technical art involved and is not the hypothetical person skilled in the art to whom a patent is addressed," Markman v. Westview Instruments, Inc., 52 F.3d 967, 986, 34 USPQ2d 1321, 1335 (Fed. Cir. 1995), a disputed word or phrase in a patent claim, as well as the technology disclosed in the specification and prosecution history, is often far beyond the court's unaided understanding. "Extrinsic evidence, therefore, may be necessary to inform the court about the language in which the patent is written." Id.

In this case, infringement hinged on the definition of the word "skinless". The patentee and supporting expert witnesses who were membranologists testified that in light of the specification and prosecution history, one of ordinary skill would understand "skinless" in terms of specific pore size, shape, and resulting way in which fluid flows through the membrane. Micron's experts countered that "skinless" refers to a visible physical characteristic of the membrane that could be viewed with an electron microscope, and requires that a membrane not visually appear to have a skin. Both of these interpretations are plausible and are adequately supported. After a lengthy trial, the district court found in favor of Pall's definition as a matter of underlying fact.

On appeal this panel unanimously agreed on an opinion which held that those findings of fact were not clearly erroneous. Then Markman intervened and this case was revisited by direction of the court en banc. Now, without explanation, where it was prepared to sustain the interpretation of "skinless" based on the findings of fact, the court says it is correct as a matter of law. I continue to believe Markman was wrongly decided, see 52 F.3d at 989, 34 USPQ at 1337, and this case is an example of why. I see no principled basis on which the court may rest its conversion of what once was mutable fact into immutable law. I can sustain the judgment of the district court as not based on clear error. Otherwise there is little for the uninitiated to choose between the contending interpretations. As far as I can see, this court's action is based on mere preference, thus illustrating the artificiality of Markman. How it fosters greater predictability and consistency in the law or a certainty that a judge will "arrive at the true and consistent scope of the patent owner's rights", id. at 978, 34 USPQ3d at 1329, is beyond my understanding.

Judge Learned Hand put it cogently: "The question was of how the art understood the term, which was plainly a question of fact; and unless the finding was 'clearly erroneous,' we are to take this definition as controlling. It is an issue which we are altogether incompetent to decide upon the merits; even the terminology is beyond our acquaintance . . . indeed the very elements themselves are in dispute among those who have made them their life study, as the merest smattering of modern physics quickly discloses to a lay reader. While Congress sees fit to set before us tasks which are so much beyond our powers, suitors must be content that we shall resort to the testimony of experts, though they are concededly advocates with the inevitable bias that advocacy engenders. " Harries v. Air King Prods. Co., 183 F.2d 158, 164 (2d Cir. 1950).

These cases often deal with the interpretation of complex scientific terms in areas of cutting edge technology. But science is not absolute, it is dynamic; and what is "truth" today is often shown to be error tomorrow. The fact finder may or may not arrive at the "true" meaning of the claims, but that problem is inherent in any judicial undertaking because an undisputed knowledge of fact is largely unobtainable. To suggest that appellate judges, precious few of whom are trained in science, will always arrive at the "true" meaning of words embodying complex concepts endows them with knowledge and enlightenment far beyond those who have training and experience in the field. They are in no position to declare the state of knowledge in the art or that scientific hypotheses are correct as a matter of law. Those who provide conflicting testimony and other evidence about scientific or technical matters should be evaluated as are any other expert witnesses and the finder of fact should decide what is the best, most reasonable result in light of the evidence presented. The trial court is the proper forum for such an

exercise. This court should review according to traditional standards.

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

PALL CORPORATION,	)	
	)	
Plaintiff,	)	CIVIL ACTION
	)	NO. 86-1427-Y
v.	)	
	)	
MICRON SEPARATIONS, INC.,	)	
	)	
	)	
Defendant.	)	

MEMORANDUM OF ORDERS

YOUNG, D.J. June 18, 1991

On May 15, 1991, the Court entered the following injunctive order at the close of the first phase of the liability case:

> . . . the claim of MSI that the Pall patent is unenforceable by reason of inequitable conduct is not proved; that MSI has not proved that the claims of the patent are indefinite, invalid due to the 1978 commercialization of the Pall nylon membrane, invalid by reason of anticipation by the disclosure of the Marinaccio patent, invalid by reason of obviousness over the prior art, invalid by reason of the work by AMF. The Pall patent is declared to be valid.
>
> Further, it's declared that MSI's infringed by virtue of its products made

> from Nylon 66. It has infringed the claims of the Pall patent, and its process for making membranes out of Nylon 66 infringes the Pall patent. The Court makes no finding on the state of the record as it now stands that MSI has willfully infringed the Pall patent, and it makes no finding that Pall is entitled to attorneys' fees.
>
> Accordingly, MSI, its agents, servants, employees, and all persons acting in concert with it are hereby enjoined, for the life of the Pall patent, from engaging in the process in which they are now engaged to make nylon membranes out of Nylon 66.

Transcript, pp. 2261-62.

On June 6, 1991, at the close of the liability phase of the case, the Court immediately made findings and rulings from the bench, including the following injunctive order:

> Accordingly, the Court finds that although there is no literal infringement in this case, given its peculiar facts, the Doctrine of Equivalents is not trumped or made inapplicable by the file wrapper history. Therefore, since Nylon 46 infringes the Pall patent under the Doctrine of Equivalents, that patent, even as to Nylon 46, is valid and infringed; and MSI is forthwith, its agents, servants, and counsel, and all persons acting in concert therewith, are enjoined immediately from any further production or sale of any items involving Nylon 46 to the same extent that the Court has already enjoined Nylon 66.

Transcript, p. 2758.

Later that same day, the Court stayed the injunction as to Nylon 46 upon the following terms:

> Accordingly, the injunction as to 46, not as to 66, but as to 46 just entered, is stayed pending an appeal on the following terms: That an appeal bond in the sum of $1,700,000 is filed with the Court, which provides that it will increase by a further $1,700,000 on January 1, 1992, and a further $1,700,000 on June 30, 1932 (sic), and that this stay is vacated by it's own terms if MSI files for reorganization or bankruptcy or at the moment -- I guess this goes without saying -- that an appeal of the Court's judgment is dismissed.
>
> Since this is an increasing bond, there has to be another provision. I expect that MSI will seek expedited hearing from the Court of Appeals of the Federal Circuit, and the increase which is to take place on January 1 and on June 30, 1991, is of no force and effect should Pall object to any advancement of the appeal, accelerated briefing schedule, or other accelerated appellate determination of the matter. Pall has to press just as hard to hang on to its judgment as Micron is pressing to have the judgment reversed. That's the only way the bond stays in effect.

Transcript, p. 2777.

On June 10, 1991, after hearing, the Court modified the stay order just quoted by 1.) reducing the initial sum of

the bond from $1,700,000 to $1,000,000; 2.) permitting the stay to take effect if the reduced bond were filed on or before Noon, Tuesday, June 11, 1991; and 3.) omitting from the stay order any reference to its being vacated should MSI seek the protection of the bankruptcy laws. Transcript, pp. 2918-19.

There the matter presently stands as the Court concludes the damages phase of the trial.

/s/_____
WILLIAM G. YOUNG
UNITED STATES DISTRICT JUDGE

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

PALL CORPORATION,	)	
	)	
Plaintiff,	)	CIVIL ACTION
	)	NO. 86-1427-Y
v.	)	
	)	
MICRON SEPARATIONS, INC.,	)	
	)	
	)	
Defendant.	)	

ORDER OF JUDGMENT

In accordance with the findings and rulings announced in open court on May 15, 1991, June 5, 1991, June 6, 1991, and June 20, 1991, it is hereby ORDERED:

1) that the judgment be entered for the plaintiff, Pall Corporation, in the amount of $4,434,291.00;

2) that defendant, Micron Separations, Inc., its officers, agents, servants, employees, and attorneys and all persons acting in concert with them are permanently ENJOINED for the life of United States Letters Patent No. 4,340,479 from infringing any asserted claim of said patent by the manufacture, use or sale of nylon microporous membrane products from nylon 4-6 or nylon 6-6; and

3) that the foregoing injunction with respect to nylon 4-6 microporous membrane products only is STAYED pending appeal of this judgment, provided that defendant, Micron Separations, Inc., has filed and maintains in the custody of the Clerk of this Court a bond

or cash deposit in the following increasing total amount: $1,000,000 on and after June 11, 1991; $3,400,000 on and after January 1, 1992; and $5,100,000 on and after July 1, 1992.

/s/_____
WILLIAM G. YOUNG
June 24, 1991 UNITED STATES DISTRICT JUDGE

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

Civil Action
No. 86-1427-Y

PALL CORPORATION,	*	
	*	
Plaintiff,	*	DAILY TRIAL
	*	TRANSCRIPT
v.	*	
	*	
MICRON SEPARATIONS, INC.,	*	
	*	
	*	
Defendant.	*	

BEFORE: The Honorable William G. Young,
District Judge

June 5, 6, and 20, 1991

THE CLERK: Calling Case no. 86-1427-Y, Pall Corporation v. Micron Separations, Incorporated. Court is in session. Please be seated.

THE COURT: Good morning, everyone.

COUNSEL: Good morning, your Honor.

THE COURT: Give me just a second to set my papers up here, and as I'm doing it let me explain how we're going to proceed.

I'm going to deliver my findings and rulings on the, on all aspects of the liability portion of the case from the bench. I reserve the right to take the bench opinion and revise it grammatically. I reserve the right to find additional subsidiary facts consistent with the facts as I describe them from the bench, as I have found them. I reserve the right to make additional and more detailed exposition of the law.

To that end, you are invited, once you review the transcript of my findings and rulings, to submit transcript and exhibit citations which any of you believe support the findings made herein. You're not precluded from moving for consideration, reconsideration obviously to point out what you think are inconsistencies and the like, but I invite you to point out those specific transcript and exhibit references in this lengthy case that you think support the findings and rulings.

This is a patent case which involves United States Patent 4,340,479 issued July 20, 1982 to the Pall Corporation involving a process for preparing hydrophilic polyamide membrane filtered media and product. The plaintiff Pall Corporation is a New York corporation having a principal place of business in Glen Cove, New York, and offices on Route 25A in Roslyn, New York. It was founded by Dr. David B. Pall of Roslyn Estates, New York, in the late 1940's. Dr. Pall is designated as the inventor of the patent-in-suit.

The action is brought against the defendant Micron Separations, Incorporated, which I'll call MSI, a Massachusetts corporation having a principal place of business in Westboro, Massachusetts. The company was formed, MSI was formed in 1981 when certain employees of a filtration company known as Millipore, named James S. Johnson and John M. Greenwood left that company and along with Edward J. Ackley decided to start their own company with, decided to start their own company and enter into competition with Pall, Millipore and others in the microporous filtration industry.

The complaint in this action was filed on May 7, 1986. It seeks a judgment that MSI has willfully infringed the patent. I'll sometimes refer to the patent as the Pall patent. It also seeks damages for past infringement and an injunction against future infringement.

Analysis starts not with the Pall patent but with the prior art, more specifically, a patent referred to in this lawsuit as the Marinaccio patent.

Pall J. Marinaccio was hired as a research chemist by AMF Company to make reverse osmosis membranes and serendipitously embarked upon microporous membrane research after it occurred to him that microporous membranes -- strike that -- after it occurred to him by looking at his polystyrene coffee cup that it might be possible to make microporous membranes out of related materials.

Marinaccio devised a process which he believed was a breakthrough in that it allowed the manufacture of microporous membranes rapidly, far more rapidly than was then the case. Marinaccio knew that at the time in the late 1960's and early 1970's when he was performing these experiments that no one else in the industry had such a process.

One of AMF's subsidiaries is a company known as Cuno. Cuno, within the AMF Corporation, a large corporation with 80 divisions, one of which is Cuno, research and development was largely centered in AMF itself. Cuno sought to have the AMF research chemists develop a microfiltration fiber filter and Mr. Marinaccio and others commenced work on such a project. They abandoned this work and instead devoted their efforts to the development of a microporous membrane. Mr. Marinaccio believed that the key to the process as he developed it were devices which prevented any air contact during the quench process, an aspect of his claimed invention which he called zero quench. I should say generally, at this point, that the general steps, the general mechanical steps for making microporous membranes were, by the time of the early 1970's, largely known to those skilled in the art of making such membranes. To the extent there are developments, they are developments in particular materials used and the manner of their use. But the developments are not in the mechanical aspects of the membrane process.

Marinaccio sought, and received, United States Patent 3,876,738 dated April 8, 1975. I'll call this the Marinaccio patent. The Marinaccio patent described this so-called zero quench process for the continuous formation deposit of membrane so as to form large sheets of microporous membranes.

Now, while Marinaccio had obtained a patent on his invention, a patent presumed to be valid, he had a number of problems within his company. Marinaccio believed that his patented process had significant commercial viability. But, as is the plaint of investors everywhere, he considered himself starved for money and that that the business leaders at AMF didn't adequately support his research efforts.

He testified, and I credit, that at AMF they were literally holding the machines together with wire and tape.

Marinaccio's concept of commercialization of his process was to make an idiot-proof membrane; that is, he constantly sought for a simple, readily understandable, generally applicable approach. Marinaccio, through the use of his invention, was able to manufacture, albeit not commercially for sale, but was able to manufacture sheets of microporous membrane which looked, as I will say all these sheets in this case look like typewriter paper, they all look to the naked eye identical. On the materials that he manufactured he ran bubble point tests and flow tests and came to believe that the material manufactured pursuant to his process was as good for microfiltration purposes as anything then commercially available.

A gentleman named Ostricher at Cuno was very enthusiastic about the samples which Marinaccio had produced, was evaluating those membrane samples against standard Cuno product with the result that the Marinaccio samples were thought to be by Marinaccio and Ostricher considerably better.

The trouble came in the commercialization of the Marinaccio process. The chief executive officer of Cuno was one Ray Tritten. Cuno, at that time, made only unsophisticated paint filters. Tritten's idea of commercialization of microporous filters was a process which resulted in long runs of membrane sheets. While certain of his subordinates thought that the sheets prepared by the Marinaccio process were good enough for commercial application, Tritten said no. Tritten was concerned in tests that Cuno ran with tap water that the filters prepared by the Marinaccio process had only a very short life. Marinaccio believed that the short life showed nothing more than the remarkable benefits to be derived from his filter inasmuch as it filtered everything out of the tap water retaining it on the filter face and quickly clogging the filter.

The rejection by Cuno of, really by Tritten, and then confirmed by AMF, the rejection of Marinaccio's efforts to commercialize the Marinaccio process as set forth in his patent did not daunt Marinaccio. He went right on testing it in an underground fashion. He, though no one had asked him, he kept on testing it.

The zero quench process that is referred to in the Marinaccio patent was assisted in the development thereof by one Rodney A. Knight who's also listed as an inventor thereof. That process was able to make short runs of .2 micron material. Long runs were not made in Marinaccio's view because he did not have the money to develop the machinery sufficiently to actually make long runs, though he believed, and indeed still believes, that he could have made long runs by his process had he only been adequately supported.

Marinaccio believed that his only failure was the equipment limitation failure. His process involved the dissolving of pellets of Nylon 66 -- strike that. Strike that. His process involved the dissolving of nylon pellets in formic acid. Marinaccio, however, recognized the problems with the long-term reproducibility of the materials formed by his process. He further recognized that the most critical test for microporous membrane is the bacteria retention test and that in ways that he was never satisfactorily able to explain various of his prototype production runs failed to meet the bacteria challenge test. Cuno did not sell any of the rolls of membranes material developed by, or developed pursuant to the Marinaccio patent.

The Marinaccio patent does not contain any indication that the products obtained by its process are hydrophilic, as that term is used in the Pall patent, and skinless. Marinaccio does not claim, the Marinaccio patent does not claim that the products produced are inherently

hydrophilic as that term is used in the Pall patent, and further teaches that the products produced should be "treated with a wetting agent." The Marinaccio patent is silent with respect to skinlessness. It comments only that a person of ordinary skill in the art may, ought recognize that a skin may result on the casting solution and therefore is likely on the final product after quenching. The Marinaccio patent teaches that the process does not require special conditions of temperature. The films can conveniently be produced at or near room temperature. In fact, temperature plays an important role in the preparation and casting of a resin to form a membrane, a point that Mr. Knight later came to think was a significant variable in getting an exact pore size control but not, thought Knight, absolutely essential to the preparation of the microporous membrane itself. The Marinaccio patent does not disclose that control of the esterification reaction resulting from the order in which the reagents are added to form the casting solution is important and affects the resulting product. The Marinaccio patent does not indicate any importance in the mixing conditions employed in making the casting resin. The Marinaccio patent teaches that increased porosity is obtained by increasing the polymer concentration to the solution and by increasing the nonsolvent concentration causing the polymer to aggregate. The Marinaccio patent is silent regarding the manner in which the membrane film that's produced is dried. It makes no mention of controlled nucleation.

Now, wholly apart from the claim anticipation of the Pall patent by the Marinaccio patent, MSI here claims that the invention of the Pall patent, the microporous membrane itself, had been reduced to practice by virtue of the rolls of microporous material which Marinaccio produced for Cuno. Pall disagrees, claiming that the Marinaccio efforts were abandoned, suppressed or

concealed by not being made public. So, a brief analysis need be made of this issue.

If a prior invention is made public or is used commercially it has not been abandoned. Friction Division Products v. E.I. DuPont de Nemours, 658 F.Supp. 998, 1014, District of Delaware (1987). The law does not require any disclosure of the actual invention to the public nor any commercial use for an invention to qualify as prior art. Hazeltine Research v. Brenner, 382 U.S. 252 at 254-256 (1965). Nor does 35 U.S.C., Section 102(g) carry a "personal knowledge requirement" on the part of the infringer. E.I. DuPont De Nemours and Co. v. Phillips Petroleum, 649 F.2d 1430, 1437, Federal Circuit (1988). Indeed, the invention need only benefit the public, that is, it must be reduced to practice. Friction Division, supra, at 1013 and 14. Reduction to practice means something less than commercialization, 1013, but requires an exposure of the benefits to the public, 1014. An invention is deemed publicly known if the public enjoys the benefits or use of the prior invention. Friction Division again at 1013-1014; see also Schreiber Manufacturing Co., Incorporated v. Saft America, 704 F.Supp. 759, 762, Eastern District of Michigan (1989). "Public use of an invention under Section 102(b) is any nonexperimental use by an inventor or by an individual. A commercial use by the inventor will bar a patent, even if that commercial use is kept secret. The determination of whether a 'public use' has occurred can only be made upon consideration of all surrounding circumstance."

In the circumstance of this case the Court finds that the rolls of material made by Mr. Marinaccio for Cuno were experimental only, never benefited the public, never were disclosed publicly, never were in use, and in fact did not anticipate the patent-in-suit, the Pall patent, as any sort of prior art.

Now let's turn to the Pall patent. Coincident, and indeed even earlier than Marinaccio, Pall was -- and now I'm referring to Dr. Pall and that's how I'll distinguish him from Pall Corporation; when I'm talking about the individual I'll refer to him as Dr. Pall -- Dr. Pall was conducting research on microporous filters made from polymeric materials, including nylon, in the mid- to late-1960's. He set aside that project in 1969 because developments in other areas were believed to be more promising. In mid-1974, Dr. Pall reactivated his research program in microporous polymeric membranes. By November '74 he made a promising microporous membrane from Nylon 11 and Nylon 612. By September 1975 he made a pliant, alcohol-insoluble, skinless microporous membrane from Nylon 66. And by November 1975 he had repeated this result on a larger scale.

Now, Dr. Pall considered the membrane that he had developed to be naturally hydrophilic. At least that's what he says in his patent application and that's what he defines in his patent. Now, a patent applicant, as the cases make clear, can be his own lexicographer, but it's important to pause for a moment and discuss what Dr. Pall says when he uses the word hydrophilic.

The general use of the word in industries beyond this industry is in a manner different from the way Dr. Pall uses it. Generally, a material is thought to be hydrophilic if the contact angle of a drop of water with the surface of the material is less than 90 degrees, and hydrophobic if the contact angle of the drop of water with the surface of the material is greater than 90 degrees. And these concepts of hydrophilicity, attractiveness to water, hydrophobicity, repelling water, are confirmed by a variety of formulas and tests involving capillary action of the material and water. Now, it's very important to a microporous membrane that it be naturally hydrophilic and the more hydrophilic the

better. Naturally hydrophilic, that is, attractive to water itself without the addition of wetting agents, because the wetting agents themselves may interact with the material being passed through the membrane and make the membrane not commercially usable. So, natural hydrophilicity is desirable. And the more hydrophilic a material is, the better it is for microporous membrane filtration in view of the need, of course, to pass the water through the material filtering out whatever is sought to be filtered out.

Dr. Pall uses the term, and the patent I find uses the term in a readily understandable fashion, but his use of the term hydrophilic is different than that term is used generally in the mechanical sciences and in chemistry. For Dr. Pall, at least by the time his patent is issued, a matter we will come back to, a material is naturally hydrophilic only if it is so readily wetted with water that no contact angle at all can be measured between the material and the drop of water because the water has gone into the material in less than one second. Now, one can understand that definition, but arguable confusion results since he defines everything else as hydrophobic, whereas in fact certain nylon blocks, pellets, solid materials, most important, as we will see further on, Nylon 46, have contact angles, in their natural states have contact angles of less than 90 degrees.

This aspect of skinlessness should also be mentioned. When he comes to obtain the patent-in-suit he makes an important point of claiming that the membranes produced through the Pall patent are skinless.

Now, skinlessness is never specifically defined in the Pall patent but it clearly is a significant parameter and it's discussed at some length, as follows, reading from Column 9 of the patent: The conditions under which the polyamide resin is precipitated determine the skinless nature of the membrane, as well as its physical

characteristics, i.e., the size, length and shape of the through pores of the membrane. Under certain conditions a membrane is formed which has through pores extending from surface to surface that are substantially uniform in shape and size. Under other conditions, the through pores are tapered, being wider at one surface and narrowing towards the other surface of the membrane.

Under conditions outside the scope of the invention, still another form of the membrane is obtained, having a dense skin penetrated by pores of smaller diameter than the pores in the remainder of the sheet. This skin is normally on one side of the membrane sheet, but it can be on both sides of the membrane sheet. Such skinned membranes are conventional in the art, exhibit relatively higher pressure drop and other poor filtration characteristics, and are undesirable.

Then in Column 26 of the patent, starting at Line 34, it says: Skinned membranes behave very differently; when water wetted and their air flow-pressure drop relationship is determined, the curve is not flat -- and the curve that is referred to here, I'm interpolating, is what's called a KL curve used in the industry -- and now going back to the quote: -- the curve is not flat initially, but slopes upward, indicating presence of large pores; transition to a more nearly vertical line is slow, with a large radius, and in the vertical area, instead of the sharp rise of Figure 3 -- the reference is to Figure 3 in the patent -- going back to the quote: a sloping line is obtained, reflecting a wide pore size range. Such membranes are poorly suited to obtain sterile filtrates when challenged by bacteria; either a nonsterile fluid is obtained, or, if sterility is gotten, it is at the cost of very high pressure drop to achieve a low throughput rate.

Stated another way, the skinlessness of the membranes was important for filtration applications

because it assured a good flow rate and acceptable pressure drops and avoided functional imperfections typically associated with skinned membranes which rendered such membranes unsuitable for use in critical filtration applications where absolute removal of all particles larger than a predetermined size must be assured. Skinlessness is also an important attribute of nylon membranes in biotechnological applications.

Dr. Pall found the immediate zero contact angle aspect of the nylon membranes produced by the process with which he was working, which he had invented, to be unexpected since he considered the source material, that is, the pellet form of the starting nylon resins, each to have a contract angle much greater than zero. This immediate natural zero contact angle occurring within one second, which Dr. Pall defines in his patent as natural hydrophilicity, was a tremendous advantage over most known commercial filtration materials which had to be treated with a surfactant to make them hydrophilic. Such surfactants invariably contaminated the filtered fluids when they shed off to one degree or another.

A pliancy of the material produced by Pall process likewise was important to facilitate handling, including pleating into high surface area cartridges.

The alcohol-insolubility is important to permit the use of nylon membranes with a wide variety of liquids.

Between 1976 and 1977 Dr. Pall developed a manufacturing process for making commercial quantities of nylon membrane. On May 15, 1978, Dr. Pall filed a parent patent application covering the products and the process for making the nylon membrane. The parent application was drafted broadly enough to encompass all alcohol-insoluble nylons which produced hydrophilic, that is, Dr. Pall defines it, skinless microporous membranes.

At the same time, Dr. Pall prepared and filed a related application which ultimately matured into United States Patent 4,340,480, not at issue herein, directed to the range of nylon which he considered useful for making liquophilic membranes, that is, those which, though not wettable by water, were wettable by certain organic liquids.

Reference must now be had to the file wrapper. My reference is to Page 112 of Exhibit 545, the date of which I know we discussed in the transcript but I don't have it before me right now.

The examiner -- and the principal examiner throughout was one Frank A. Spear, Jr. -- initially took the position that Claims 1 through 97, which were the claims in the initial application, were all subject to certain restrictions which he listed. In response to his direction that the claims be restricted, on May 15, 1978, a document entitled "Amendment" was filed seeking reconsideration of the requirement for a restriction in which Pall claimed that the claims of Group Roman numerals I, II and III are drawn to one indivisible invention based on the process which is defined in Claims 1 to 31, 56 to 66, 96 and 97. As a result of this process it has been found possible to prepare a skinless, hydrophilic, alcohol-insoluble polyamide membrane, which itself is new and patentable because it was never before made available, and indeed no process was known for preparing it. The words skinless, hydrophilic, alcohol-insoluble are underlined for emphasis. And, indeed, that is the thrust of the patent applicant, that he had, and his concern with restriction that what had been invented here was this skinless, hydrophilic, alcohol-insoluble polyamide membrane.

Nevertheless, in an action mailed on June 4th, 1979, Claims 1 through 86 and 96 and 97 were rejected by the patent examiner, Claims 87 through 95 having been withdrawn. The ground of the rejection is significant. The

examiner took issue with the use of the word "hydrophilic" in the original application, quoting now, quote, because it has no absolute meaning, close quote. Well, stop the close quote. Because it has no absolute meaning. It is a relative term, close quote. In this the examiner was precisely correct and indeed focused on the point that Dr. Pall, as a patent applicant, was defining hydrophilic in a manner somewhat different than it had generally been understood. Other claims were rejected because the use of the support for the membrane had already been revealed in the prior art, including the Marinaccio patent. Claims 3 and 4 were rejected as unpatentable over Marinaccio with respect to the manner in which Marinaccio had filtered the casting dope. Claims 56 through 66 were rejected as unpatentable over Marinaccio and others on the ground that it was obvious to use multiple layers in a membrane and that had been shown in Marinaccio as modified by other patents. Claims 75 through 86 were rejected on the ground that it, that, quote, it would be obvious to use a solution ready to precipitate in Marinaccio, close quote, and reference is made to other patents.

Well, that did not slow Dr. Pall down. He came back requesting in a document entitled "Amendment" and in response to the action of June 4, 1979, he states, at Page 129 of Exhibit 545, that the applicant agrees that the term hydrophilic is perhaps susceptible of being misunderstood because it is not precise. And then he goes on to explain exactly what he means, saying, in relevant part, on Page 129 of the exhibit, a very high angle of contact indicates very poor wetting, while a zero angle of contact defines complete or perfect wetting. While the polyamide resins from which the membranes of this invention are made have a high angle of contact and are not wetted by water, the membranes of the invention have a substantially zero contact angle because they are readily

wetted by water, and an amendment is made to Claim 27 accordingly.

It's pointed out that all claims, including the claims objected to by the examiner, which use the term hydrophilic have now been further amended so as to indicate either that the membrane has a substantially zero angle of contact with water or that the membrane is readily wetted by water. This defines hydrophilicity in a precise way and also distinguishes the applicant's membranes from the membranes of the prior art. The fact is that the polyamide resins from which the membranes of this invention are made have a high angle of contact with water and are not wetted by water.

At this stage in the application process, Dr. Pall then goes on, at Page 130, to make the statement, however, when in dealing with the examiner's concern as to which nylons are, and whether particular types of nylons are critical elements of the process, goes onto say, quote, However, there is nothing critical in the polyamide resin apart from its being alcohol-insoluble. The applicant believes that the invention is applicable to any alcohol-insoluble polyamide resin, and has said so, not only in the broad claims but also in the broad statements of the invention at Pages 15 to 21. Throughout this portion of the specification, the term "polyamide resin" is used generically to encompass the entire class of alcohol-insoluble hydrophobic polyamide resins. The word hydrophobic is used there, I infer, in the sense of being opposite to the way Dr. Pall has defined hydrophilic.

And, on Page 131 he says: This being so, and there being no prior art requiring a narrowing of the claims in this respect, the applicant proposes to maintain the present scope of polyamide in the claims.

Well, then on a date that has been discussed in the transcript, but I can't figure it out from this particular

exhibit, on Page 165, of Exhibit 545, the examiner nevertheless rejects all the claims and he's somewhat more, his rejection is in somewhat more detail.

Now, one of the key elements of Dr. Pall's claimed invention is what he calls, and what has been called in this trial, controlled nucleation. But the examiner, at least at this stage of the application, rejects the claims, stating that it would be obvious, putting aside support now -- strike that. He rejects them on Page 166, saying it would be obvious to use the support of Brown and others in Marinaccio, and by support I infer he means there the polyester support for the membrane sheet. But now he goes on, the examiner does, it is submitted that there is some nucleation in Marinaccio and others. For instance, during the addition of small amounts of nonsolvent there would come a time when a small amount of precipitate would form temporarily and immediately redissolve. In fact, the applicant's specification, Pages 43 to 44, suggests there is some nucleation in Marinaccio. Then, he continues to believe that it would be obvious to filter the casting dope and that's not an advance over Marinaccio. It would be obvious to use multiple layers. Not an advance over Marinaccio and others. He makes reference to the Sharp membrane being hydrophilic in the sense that they have produced membranes, and so has Marinaccio, which are "more readily wettable than prior art films." And he makes the statement one would obviously expect a very thin, very porous film to be completely wettable throughout as claimed. He, the examiner, anyway, obviously didn't think there was very much to this invention, at least at this time. The rejection for multilayers is maintained. And then, again significantly, the examiner rejects the application, saying it would be obvious to use a solution ready to precipitate in Marinaccio as shown by Lovell, and to filter it as shown by Jamison.

Well, that didn't stop Pall and his people, either. And on an examiner interview dated May 2nd, 1980, it's indicated that all claims were discussed, Marinaccio, Brown, Sharp, identified as prior art, and the examiner then says, he's received what he terms a, quote, impressive demonstration, close quote. Examiner, quote, examiner will consider 132 declarations in detail while reflecting on the demonstration. Check examples for support of 6-10, and I can't make out the next word, but I assume, I infer that that has to do with -- oh, 6-10 carbon atoms. And then he quotes, Markush looks promising, close quote.

Now, it appears that they had discussed at this interview a new approach to defining what it was that's claimed. Because in a document entitled "Amendment" dated May 5, 1980, three days after the interview to which reference was just had, the initial claim is amended, as follows. And I'll highlight the amendment. It's claimed that, the invention is in Claim 1, a process for preparing skinless, hydrophilic, alcohol-insoluble polyamide membranes that are readily wetted by water which comprises preparing a solution of an alcohol-insoluble polyamide resin, and now I'm adding the amendment, selected form the group consisting of polyhexamethylene adipamide, polyhexamethylene sebacate, and poly-e-caprolactam -- that's the addition -- in a polyamide and then add the word resin solvent, inducing nucleation of the solution by controlled addition to the solution of a nonsolvent for the polyamide resin, et cetera. And these same limitations, selected for the group that I just read, follow on. Then in the remarks section, reading from Page 178 of Trial Exhibit 545, it is stated that: As indicated at the interview, Claims 1, 32, 56, 67, 75, although not rejected on the grounds of undue breadth, are amended because on the basis of research done since this application was filed, the applicant now considers that the

process described and claimed herein is actually applicable only to polyamide resins which are polymers of hexamethylene diamine and aliphatic saturated dicarboxylic acids having from six to ten carbon atoms. As indicated at Page 22, Lines 12 to 14, the preferred polyamide resins now recited in these claims in a Markush group are polyhexamethylene adipamide, Nylon 66, poly-e-caprolactam, Nylon 6, and polyhexamethylene sebacamide, Nylon 610. These embrace the limits of the class of saturated aliphatic dicarboxylic acids having from six adipic to ten sebacic carbon atoms.

Then, with respect to the rejection for, with reference to nucleation in the Marinaccio patent, over on Page 213, the applicant states, omitting -- well, no, I won't omit anything. These claims, Claims 75 to 86, the reference is to, are directed to a casting resin solution for forming hydrophilic skinless microporous polyamide membranes that have a visible precipitate of polyamide resin formed during the addition of the nonsolvent, and that is nucleated by virtue of the addition of the nonsolvent under controlled conditions of solvent, of nonsolvent, and of resin concentration, temperature, mixing intensity, addition time, and system geometry, resulting in this visible precipitate. This rejection is accordingly answered by the discussion above of the phenomenon of nucleation vis-a-vis the disclosure of the Marinaccio patent in connection with the rejection of Claim 1 on Marinaccio. The Marinaccio disclosure clearly teaches one not, underline the not, to use a solution which contains a visible precipitate. The solution with nonsolvent cannot proceed this far, but only up to the point of incipient precipitation of the nylon. This is before a visible precipitate is formed, not after. Note Column 6, Line 6 to 9 of the reference. Thus, to use a solution that contains a visible precipitate is to proceed contrary to the Marinaccio disclosure as noted above.

Now, there matters stood until a continuation-in-part was filed on a date I can't quite figure out, but I'm sure it's not in dispute and you can supply it. And in the continuation-in-part the full abstract of the disclosure is discussed. My reference now is to trial Exhibit 544 of the continuing application. Oh, here it is. Filed October 20, 1980. So the last reference I had was in May, now here in October the continuation is filed. And the continuation-in-part now goes on to define the invention, or redefine it, get at it in a different way, by what we have called in this litigation the ratio claims. And I read from Page 123 of Exhibit 544.

The application Serial No. 905,698, has been refiled to provide basis for a narrow subclass of polyamide resins disclosed in Serial No. 905,698 that forms such skinless hydrophilic membranes. All members of this class have a ratio CH2 to NHCO of methylene, CH2 to amide NHCO groups within the range from about five to one to about seven to one, including polyhexamethylene adipamide, Nylon 66, poly-e-caprolacatam, Nylon 6, polyhexametehylene sebacamide, Nylon 610, poly-7-aminoheptanoamide, Nylon 7, polyhexamethylene azeleamide, Nylon 69, and mixtures of two or more thereof, as well as mixtures thereof with higher polyamide homologues such as polyhexamethylene dodecandiamide, Nylon 612, in portions such that the mixture has an average of CH2 to NHCO ratio within the stated range. The first three polyamides, Nylon 66, Nylon 6 and Nylon 610, are preferred.

The other polyamides disclosed in Serial No. 905,698 have been found not to form hydrophilic skinless membranes. Such of them, those that have a ratio CH2 to NHCO of methylene CH2 to amide NHCO groups within the range from about seven to one to about twelve to

one, form skinless liquophilic hydrophilic membranes. The others form hydrophobic skinned membranes.

Now, then, on August 24, 1981, the examiner allows Claims 1 through 76, 111 through 115; rejects claims 77 through 110, 116 through 172. He makes the following note at Page 168: The broadly recited amide having the claimed ratio of CH2 to NHCO groups in unwarranted in view of the disclosure. The various mixtures in that range are particularly unsupported. Only one mixture appears in the examples, Exhibit 68. Most of the examples involve only Nylon 66. The interview of the, the summary record of the examiner interview shows that all the rejected claims were discussed, that there was no rejection based on prior art, and then he says amide looks promising. No strike that. Amendment looks promising. Discussed three options. All would clear up Claim 87. And the amendment to which exhibit, to which reference is made is the amendment that follows on Page 172, and the most significant language therein is under remarks and it reads, as follows. Well, I'm going to save time by not reading it but simply by inserting in the opinion the last three liens of Page 173 down through the entire Page 174.

The patent issues on July 20, 1982.

And I think this is a good time to take a recess and we'll recess for about, we'll recess until 11:30, and we'll go on until 1:00 if I'm not done prior to 1:00. We'll recess.

(Recess.)

THE COURT: Now, at this juncture it's helpful to put these matters in some perspective.

Polymeric membranes are thin, sheet like materials with very small interconnected pores. The pores usually range in size from about one-tenth of a micron to ten microns. The members are made from a chemical material that has many thousands of repeating units, a polymer.

There are many such materials, many methods for making them into membranes, and many uses for such membranes.

Polymeric membranes, in the strictest sense of the word, may be fibrous or non-fibrous. Usually, however, when the term polymeric membrane is employed, the non-fibrous type is meant. Non-fibrous membranes are usually made directly from a solution or melt of the polymer. Fibrous polymeric membranes are made by first converting the polymer into fibers, and then making a thin web from those fibers. Potassium titanate is a good example of a fibrous polymeric membrane.

Prior to the development of the Pall nylon membrane, fibrous filter media, made, for example, from potassium titanate or asbestos, were commonly employed as filtration medium. At the present time, the two most commonly used microfiltration membranes are Pall's nylon membrane and Millipore's PVDF membrane, both made from non-fibrous polymers. They are employed mainly in the filtration of liquids to remove very small particles, including bacteria, a process known as microfiltration.

Depending upon their use, polymeric membranes may have a skin on them, or they may be without a skin. Certain processes, reverse osmosis, for example, require the presence of a continuous skin, while in other processes microfiltration, for example, the complete absence of any skin is necessary.

Microfiltration is one of the most common applications for polymeric membranes at this time. It is, however, by no means the only application. Membranes are also used in reverse osmosis, electrophoresis, dialysis, electrodialysis, gas separation, and immobilization and transfer of substances.

Microfiltration is the regime with pores between about one-tenth of a micron and 10 microns. The most important pore size is .2 microns because this is the largest

pore and hence gives the highest flow rates and throughputs consistent with the retention of the approximately .3 micron Pseudomonas diminutia bacteria which is the criterion for sterilizing pore size rating. Today microfiltration membranes are skinless and macrovoid-free and have a narrow pore size distribution which maximize their efficiency at removing bacteria, and other particulate matter of equivalent size, from fluids.

I'm going to amend that sentence simply to add the words commercially acceptable today microfiltration membranes, and then the rest of the sentence.

Other uses for microfiltration membranes are now found more and more in the biotechnology area. Polymeric membranes are there employed, for example, to hold certain substances such as antibodies, antigens or other proteins while blood or other body fluids are passed through the membrane.

Over the years, many different polymers have been investigated as possible membrane media in a number of different applications. By the late 1970's, the list included the following, without any attempt to be exhaustive, and here I'm inserting Page 7 of the direct testimony of Dr. Kesting.

By 1978, many methods had been investigated for making the polymers mentioned above, and many other polymers not here mentioned in porous membranes. They included: casting membranes from a melt of the polymer; casting from a polymer solution into an evaporative atmosphere; casting from a polymer solution into a nonsolvent liquid; stretching semi-crystalline films; thermal gelling by decreasing the temperature of the polymer solution; inducing porosity by irradiation of polyester and/or polycarbonate films, binding the polymer into a thin sheet structure by sintering.

In 1978, the leading manufacturers of microfiltration media were Pall with its fibrous potassium titanate product, and Millipore with its membrane made of a mixture of cellulose nitrate and cellulose acetate. Several other membrane products were on the market, but none had any significant market share. Most, if not all, of the polymeric non-fibrous membranes were made by a process that involved casting from a solution following by evaporation or quenching in a liquid.

Pre-1978 filter media, fibrous and non-fibrous, suffered from one or another of a number of deficiencies, as follows: Brittleness. Unless highly plasticized, they could not be pleated and incorporated into a cartridge.

Marginal Thermal Stability. The membrane shrank excessively while being sterilized with steam.

High Extractables. The surfactants employed to render the membranes hydrophilic so that they could be used with aqueous fluids and plasticizers required to permit the membranes to be made into useful products leached out of the membrane while in use.

Poor Solvent Resistance. The membranes softened or dissolved when used in certain solvents.

Limited Flowrate. The amount of liquid per unit time capable of flowing across the membranes was limited.

Limited Throughput. The membranes clogged easily and thus had to be exchanged frequently.

Limited Sterilizing Ability. The membranes could not consistently produce bacteria-free fluids.

Poor Dimensional Stability. The membranes swelled in water.

Danger of Fiber Sloughing into the Permeate. Unless specially treated, fibrous materials tend to slough off fibers into the permeate.

By 1978, the industry had recognized the desirability for a new type of membrane and had pursued

many avenues of reaching that goal. All such attempts had failed.

Dr. Pall invented the first naturally and instantaneously wettable, completely skinless, and alcohol-insoluble polymeric membrane and a process for making it. The membrane was suitable for service in severe solvent environments and for sterile filtration. It was strong and pleatable so that within plasticizers it could be made into a cartridge. It met all of the criteria the industry had long sought. And remarkably, it was made of nylon, a material that had been investigated several times before without success.

The process invented by Dr. Pall, and described in his patent, to prepare the membrane involved the preparation of a precisely nucleated casting solution made up of solvent, nonsolvent and nylon, casting that solution into a film and quenching the film in a bath containing solvent and nonsolvent. While it had been know to prepare membranes by casting solutions of polymers, the step of precisely controlling the nucleation of the solution prior to casting thereby to achieve certain properties such as particular pore sizes, or skinlessness, was altogether new and represented a breakthrough in the art.

Dr. Pall was the first to recognize the connection between true skinlessness, pore size distribution, and the titre reduction of bacteria passage. This is now recognized to be one of the main advantages of skinlessness in microfiltration membranes. Prior to Dr. Pall's invention, a titre reduction of 7 was the standard, and few besides Dr. Pall strove to increase the titre reduction. Millipore, for example, spoke in terms of such erroneous concepts as absolute retention and pore sizes of .22 microns.

Clearly the understanding of microfiltration at that time was vastly less sophisticated than it is now. The efforts of Dr. Pall and his colleagues were of great

importance to the theoretical aspects of microfiltration and helped moved microfiltration from an art to a science. Pall's papers described the first studies which addressed the theory of microfiltration in a thoroughly scientific and at the same time practical manner. Pall and his associates were pioneers both in the invention, development and commercialization of functional nylon microfiltration membranes and in the theory of microfiltration. Such practices as the determination of the KL curve rather than the bubble point as an integrity test were introduced by Pall.

To a person of ordinary skill in the art, setting out in 1974 to development a new polymeric membrane free of all the then-existing disadvantages, there was little guidance as to what polymers and that methods for membrane formation should be pursued. A great number of polymers and casting methods had been tried without success. Such a person faced initially two broad choices:

Either improve the properties of the conventional membrane polymers especially those of the cellulosics and mixed cellulosics. This approach was a good one in that the materials were already accepted by the market place and the processing characteristics of these materials was well understood.

The other general approach was to look to polymers other than cellulocics which had intrinsic properties superior to those of the cellulosics. It was a reasonable assumption -- but by no means a certainty -- that superior bulk polymer property could be transferred at least in part to the high porosity, high surface area bodies which constitute microfiltration membranes.

A worker skilled in the field in 1974 could not have predicted what processing steps would be required to achieve the Pall membrane, or even how the various required processing steps would affect the starting material.

The controlled nucleation in the Pall process is critically important to the pore size and pore size distribution of the resultant membranes. The composition of the gel bath will determine the rate of gelation and the presence or absence of skinning which in turn can influence wettability as much as the intrinsic polarity of the nylon material itself.

In the Pall process, the rate of nucleation and of crystallite growth is precisely regulated. The end effect is to provide for sufficient surface area and hence non-polymer-to-polymer-hydrogen-bonded amorphous amide (CONH) groups which are free to hydrogen-bond with water molecules and hence render the membrane instantaneously wettable. The restraint of the membrane during drying ensures that the pores remain open and the concentration of non-polymer-to-polymer-hydrogen-bonded to amorphous amide groups remains high enough to ensure spontaneous wetting.

Nylon was not considered as a candidate by most membranologists in the mid 1970's for a number of reasons. Nylon 6,6 was known to be very sensitive to oxidation by, for example, sodium hypochlorite (chlorine) solutions. Since most membranologists entered the microfiltration membrane field via reversion osmosis where chlorine resistance was an important desideratum, it tended to be dismissed out of hand. The fact that chlorine was not typically encountered in microfiltration was not considered. Nylon 6, 6 was known to be somewhat polar, but many indices suggested that it was less so than the cellulosics which did yield spontaneously wettable membranes without surfactants. There was little understanding of how to control the dope formulating, casting and quenching processes for nylon membranes.

Marinaccio, of course, was one of the individuals who appreciated at least in part the potentiality of nylon as

a use, as a membrane product. Marinaccio's patent was known after 1975 and it was also known there was no corresponding commercial microfiltration product. It was, therefore, concluded that Nylon 6, the Marinaccio referred embodiment, was, for some unknown reason, not an adequate membrane polymer.

The very poor quality of the Marinaccio disclosure and the inclusion therein of polystyrene, a substance which may have led him down the right track but for which no membrane could possibly ultimately be constructed, suggested that the Marinaccio patent was simply a closeout of a failed product.

Formic acid is not a pleasant casting solvent. It has a highly acrid odor and is corrosive. It also leads to scarring of skin tissue and, therefore, must be handled carefully. At that time, more innocuous solvents such as acetone were employed.

There was no way a worker in the field in 1974 or later -- well, I'll say 1974. Strike that. -- could have predicted the properties of the final membrane product, particularly its natural and instantaneous wettability and the absence of any skinning.

The hydrohilicity of the Pall patent, defined as the complete and very rapid penetration of water to the entire thickness of the membrane, is a property of great importance to the membrane user because the membrane filtration system must be subjected to an integrity test, either a KL or bubble point test, prior to filtration to guarantee the sterility of the filtrate. The presence of even a single small unwetted portion of the membrane will permit the flow of air through this domain, and lower the apparent KL curve or bubble point of the membrane element. Thus a membrane with an actual bubble point of 50 psi, which would suffice for sterile filtration, may only exhibit a value of 30 psi, which is inadequate for sterile

filtration. The user would have no choice but to dissemble his filtration system and replace the membranes or membrane cartridge. This would have adverse economic consequences to the user - labor, cartridge replacement, cost, and to the membrane producer - loss of credibility. Therefore, instantaneous and complete membrane wettability is a practical product property necessity. It is also essential that wettability be a permanent property which will not change with the storage time at ambient conditions, temperature and relative humidity within the range normally encountered during storage and transport.

It was not possible in 1978, or even in 1989 for that matter, to predict wettability of a nylon microfiltration membrane of a given pore size from its intrinsic properties.

Any prediction of complete wettability within one second through the, or two seconds through the entire thickness of a porous membrane is impossible by extrapolation from the bulk properties of nylon polymers.

The presence of skinning on microfiltration membrane greatly reduces the concentration of accessible surface area and hence the concentration of accessible CONH groups. This in turn retards spontaneous and instant wettability.

The microporous filtration industry reacted very favorably to the claims of the Pall patent and its commercial application since wettability with no surfactants was an extraordinarily desirable result. Scientists in the area, however, continue to express doubt that Nylon 66 could be used to form a sufficiently hydrophilic membrane to be spontaneously wettable in the membrane form without a surfactant. This is an example of the advance of the Pall patent over the prior art.

The nylon membranes covered by the Pall patent have numerous applications, primarily in filtration and as immobilization media in biotechnological applications. To

date, Pall alone has sold about $400 million worth of its nylon membrane products in the aggregate.

Typical filtration applications include use by pharmaceutical companies to assure that drugs, that the drugs they make are free of bacteria contamination, use by electronic companies which require highly purified water for chip manufacture, and use by hospitals to assure that the fluids administered to patients are free from bacteria and other contaminants. Typical biotechnological applications include use in diagnostics to detect the presence of antibodies and the so-called transfer membranes for identification of genetic characteristics.

In 1978 Pall, at a time following the initial filing of its patent application, but prior to the filing of its continuation-in-part, Pall sold its membrane product commercially. It is claimed that this commercial sale of the membrane product produced by the process for which Pall later was issued a patent is an anticipation violative of Section 102(b) in that the ratio claims of the patent added in the continuation-in-part are not entitled to the filing date of the parent application and, therefore, are invalid under Section 102(b) due to Pall's earlier sales of nylon membranes.

MSI, to support that conclusion, must prove by clear and convincing evidence that the ratio claims are not entitled to the filing date of the parent application. Ralston Purina Company v. Far-Mar-Co., Inc., 772 F.2d, 1570, 1573, 74, Federal Circuit (1985). The ratio claims are entitled to the filing date of the parent application under 35 U.S.C., Section 120 if the disclosure of the parent application complies with the enablement description and best mode requirements of Section 112. Compliance with the best mode enablement requirements are not contested in this case. The description requirement is met if the disclosure of the parent application would have reasonably

conveyed to one of ordinary skill that Dr. Pall had invented the subject matter of the ratio claims when he filed the patent. In re Smith, 481 F.2d 910-914, Court of Claims and Patent Appeals (1973). The methylene to amide ratio was well-recognized as an inherent property of nylons at the time of the original application in 1978. Accordingly, the Court finds that the methylene to amide ratio was impliedly disclosed in the parent application and the addition of the express language in the continuation-in-part application did not constitute new matter. Since the ratio claims recite an inherent property of the group of nylons disclosed and claimed in the parent application, for use in membrane manufacture, the description requirement is satisfied. Kennecott Corporation v. Kyocera International, Inc., 835 F.2d 1419, 1421-23, Fed. Cir. (1987), cert. denied 446 U.S. 1008 (1988).

Accordingly, MSI has failed to prove by clear and convincing evidence that the ration claims are not entitled to the filing date of the parent application, and since the filing date of the parent application is prior to the alleged invalidating sales of membranes the assertion of invalidity under Section 102(b) fails.

I've already spoken about the prior invention disclosure under 102(g). Let's talk about the anticipation of the Pall patent by Marinaccio.

In order for a prior art reference to anticipate a claim of the Pall patent, two conditions must be met. First, all of the elements that claim must be found either expressly or inherently in that single reference. Second, that single reference must enable one skilled in the art to practice the claimed invention without undue experimentation. Akzo v. United States International Trade Commission, 808 F.2d 1471, 1479, Federal Circuit (1986), cert. denied, 482 U.S. 909 (1987).

For a process to anticipate a product the process must consistently reproduce the product. W.L. Gore and Associates, Incorporated v. Garlock 842 F.2d 1275. Strike that. W.L. Gore and Associates, Incorporated v. Garlock, Incorporated, 721 F.2d 1540, at 1554, Federal Circuit (1983), cert. denied, 469 U.S. 851 (1984).

In this case, the Court finds that the Marinaccio patent, though certainly an advance, fails to disclose to one skilled in the art all of the elements of any of the claims at issue in the Pall patent. More specifically, it fails to disclose in a manner which would allow a person skilled in the art to practice the aspects of controlled nucleation, the concern over temperature, the concern over skinlessness, the inherent wettability, and therefore the Court rules that the Marinaccio patent is not an anticipatory reference such as to invalidate the Pall patent. United States v. Adams, 388 U.S. 39, at 50 (1966).

Moreover, the Marinaccio patent is silent with respect to what, if anything, happens to a product made in accordance with its processes when heated to a temperature just below the softening temperature of the product. The work that Dr. Johnson did on Nylon 66 while at Millipore, I am not convinced that there was any public disclosure thereof or commercial embodiment thereof, or that in fact there was an invention which would anticipate the Pall patent.

MSI claims that the Pall patent failed because it is obvious. The issue with respect to obviousness is whether MSI has established by clear and convincing evidence that the differences in the asserted claims of the Pall patent over the prior art would have been obvious to a person of ordinary skill in the art when Dr. Pall made his invention embodied in those claims. 35 U.S.C., Section 103. Obviousness is a question of law. It's based on factual

inquiries and factual evidence. Graham v. John Deere Company, 383 U.S. 1, at 17 (1966).

The issue of obviousness requires inquiry into the following areas: the scope and content of the prior art; the differences between the prior art and the patent claims at issue; the level of ordinary skill in the art at the time the invention was made; and objective evidence that may indicate obviousness or non-obviousness. Graham, 383 U.S. at 17-18.

The issue of obviousness is determined entirely with reference to a hypothetical person having ordinary skill in the art. Standard Oil Co. v. American Cyanamid Co., 774 F.2d 448, 454, Federal Circuit (1985).

Factors that may be considered in determining the level of ordinary skill and the pertinent art include: the educational level of the inventor; types of problems encountered in the art; prior art solutions to these problems; the rapidity with which innovations are made; the sophistication of the technology; and the educational level of active workers in the field.

Environmental Designs Limited v. Union Oil Company 713 F.2d 693, 696, 697, Federal Circuit (1983), cert. denied, 464 U.S. 1043 (1984).

A person of ordinary skill is presumed to be one who thinks along the line of conventional wisdom in the art and is not one who undertakes to innovate. Standard Oil, supra, at 454.

The Court has made the findings relevant on this issue with the exception of objective evidence of non-obviousness and objective evidence of non-obviousness may well be the most pertinent probative and revealing evidence available to aid in reaching a conclusion with respect to this issue. Demaco Corporation v. F. Von Langsdorff Licensing Limited, 851 F.2d 1387, 1391-92, Federal Circuit, cert. denied, 488 U.S. 956 (1988).

Both the Pall and the MSI product literature emphasize the sales of nylon membranes by both of them, MSI having some $17 million worth of such sales, are directly attributable to the advantages offered by the invention of the Pall patent, including its natural wettability, uniform porosity and skinlessness. MSI indeed considered Pall's nylon membrane to be revolutionary in the art. MSI's marketing information characterized its Nylon 66 product as, quote, the first innovative product to be introduced to this market in 20 years. The nylon membrane has no extractables because of its natural wettability and is virtually indestructible, close quote. The introduction of nylon membrane permitted Pall to surpass Millipore as the leader in microfiltration membranes. The industry was surprised by Pall's introduction of a skinless nylon membrane which was naturally wettable without the presence of surfactants because others had failed to achieve such a membrane. The introduction of Pall's nylon membrane represented a major breakthrough in the filtration industry. As recited above, AMF/Cuno had abandoned its nylon membrane project because of technical problems. Other investigators and scientists in the field, including Dr. Kesting, were surprised by Pall's introduction of nylon membrane because they had been unsuccessfully trying to obtain a membrane that was naturally wettable without the presence of surfactants for many years. Commercial success is a strong factor favoring non-obviousness. Akzo, 808 F.2d, supra, at 1481. MSI has failed to prove by fair and clear and convincing evidence that any of the claims in issue in the Pall patent would have been obvious in light of the prior art.

It's claimed that the Pall patent is not sufficiently definite. Of course, it's unquestioned that in accordance with 35 U.S.C., Section 282 the Pall patent is presumed

valid. Roper Corporation v. Litton Systems, Incorporated, 757 F.2d 1266, 1270, Federal Circuit (1985.)

MSI has the burden of proving all of its allegations of invalidity and unenforceability by clear and convincing evidence. American Hoist and Derrick Company v. Sowa and Sons, Incorporated, 725 F.2d, 1350, 1358, 1360, Federal Circuit (1984), cert. denied, 469 U.S. 821 (1984).

The clear and convincing evidence standard is one that has received a great degree of criticism in the law generally. This Court has heard it referred to by an appellate court as well, it's a fa preponderance of the evidence standard, but we mean it. The Federal Circuit does somewhat, is somewhat more precise and defines clear and convincing evidence in Buildex, Incorporation v. Kason Industries, Incorporated 849 F.2d, 1461 at 1463, Fed. Circuit (1988) as an abiding conviction that the truth of the factual assertions are highly probable.

Here, to the extent MSI relies upon prior art that has previously been considered by the patent office during the prosecution of the patent application, MSI's burden of proving invalidity is especially heavy. Polaroid Corporation v. Eastman Kodak Company, 789 F.2d, 1556, 1560 Federal Circuit, cert. denied, 479 U.S. 850 (1986).

Now with respect to the definiteness of the Pall patent. What's required are claims which, when read in light of the specifications, reasonably apprise those skilled in the art both of the utilization and scope of the invention and are as precise as the subject matter permits. Such claims are not indefinite. Hybritech, Incorporated v. Monoclonal Antibodies, Incorporated 802 F. 2d 1367, 1384, 1385, Federal Circuit (1986), cert. denied, 480 U.S. 947 (1987).

I mentioned above that there are many cases that confirm that every patentee may be his own lexicographer citing W.L. Gore Associates, supra, at 1569. This means

that a patentee can choose his own terms and use them as he wishes so long as he remains consistent in their use and makes their meaning reasonably clear. Ellipse Corporation v. Ford Motor Company, 452 F.2d 163, 171, Seventh Circuit (1971), cert. denied, 406 U.S. 948 (1972).

With respect to the challenges raised in this case, the use of the terms about, hydrophilic and skinless does not impart invalidity to the claims of the patent but the meaning of those terms is to be considered in determining infringement. Andrew Corporation v. Gabriel Electronics, Incorporated, 847 F.2d 819, 821, 822, Federal Circuit, cert. denied, 488 U.S. 927 (1988).

Now, I think that takes care of the defenses. What I said about the, that there was no new matter in the continuation-in-part means that the claims of fraud on the patent office is inappropriate and that claim falls, a matter which was decided earlier in the lawsuit but which I've now explained.

Likewise, the Court finds that the Pall patent is adequately definite; that it is not anticipated by virtue of its own 1978 commercialization of its nylon membrane; the Marinaccio patent does not anticipate the Pall patent; the Pall patent is not obvious when tested against the AMF/Cuno nylon membrane project which was terminated with no disclosure or benefit to the public, or when tested with respect to the Millipore Nylon 66 project which is likewise of, had no disclosure or benefit to the public.

The prior art that was known, the Pall patent was not obvious in light of that prior art, and I have detailed the level of skill in the prior art, the commercial success of the Pall patent, the surprise and recognition of the industry, and failure by others.

So let's come to the issue of infringement. And with respect to infringement the first finding, the first series of findings relate only to the process insofar as it results in

MSI products made, sales of microporous membrane made by MSI from Nylon 66. And I'll incorporate in the opinion the specific parallel claims set out in the requested findings of fact as found in the Pall patent on Pages 6, 7, 8, 9 and requested finding of fact 22 in Pall's proposed findings of fact filed on May 15, 1991 without reciting them here.

Now, all of this is with respect to Nylon 66 only. Now, I've mentioned the definition of hydrophilicity as that term is used in the Pall patent. Under that term, MSI's Nylon 66 membranes are hydrophilic as matter of fact. The matter of skinlessness is a matter of significant import here. If you look in the naked eye at the Pall membrane and the MSI membrane they look and feel identical. If, however, you blow the -- I guess that's -- I'll strike that. You're not blowing it up. If you magnify the cross-sectional view of a Pall membrane and an MSI membrane, or you magnify a top down or bottom up view of both those membranes, thousands of times by a scanning electron microscope, they look substantially different. And if you look at the Pall membrane it seems clear to this Court that under a magnification of thousands of times under a scanning electron microscope the, at least one surface of the MSI membrane frequently has, has, when compared to the interior of that membrane, a surface where the pore size looks significantly different. And I don't intend to strain at the point. As one would commonly understand the term, if you look at MSI membranes they look like they have a skin, or a lot of them look like they have a skin, if skin is a, as one takes the analogy from the epidermis of the human body, a coating that is of substantially, what appears to be substantially less porosity than the interior.

Now, one would have to sneeze at the, at the obvious photographic evidence to say that at 2,000, 5,000, 10,000 times magnification the MSI membranes look like the Pall membranes. They don't. What's more, in the

interior of the MSI membranes, there are voids, what appear to be bubbles. And sometimes these appear on the surface. Sometimes the, a bubble captured on the surface has a, in a membrane that is supposedly rated .2 microns voids, if you will, that are as big as ten microns, I think the transcript will support. So they look different.

And as the term is colloquially used, they look skinned. However, the definition of skinlessness as used in the Pall patent is one which does not depend on visual inspection, although scanning electron microscope examples of a Pall membrane are included in the Pall patent. The definition, rather, depends upon the characteristics. And skinlessness is defined -- well, I take that back. In part, it does depend on how it looks; that is, in part it's defined as having pores which are substantially uniform in size and shape. And then in part skinlessness is defined as the characteristics which allows the passage of water through the membrane in specific fashion as measured by the KL curve, all, in my judgment, adequately defined in the patent.

Now, in this case Pall contends that the actual functioning of the MSI membrane is the same as the Pall membrane. And at least insofar as that functioning helps define skinlessness, I find that Pall's correct. The KL curves of the MSI membranes tested, I find, under adequate and standard scientific fashion, are so sufficiently similar that the KL curves of the Pall membrane, especially those portions of the curve that show that the pressure is flat or some substantially increase in pressure and then abruptly, abruptly curves upward rather than a gradual curve upward, which is explained by the fact that the pores of the membrane itself, that is, the through pores, the pores that go from one side of the membrane to the other, are all substantially the same size. I find that these membranes, as so defined in light of their characteristics, the MSI

membranes are skinless. It does appear that the art as practiced by MSI is less perfect that Pall, but an infringer cannot take refuge in the fact that he has a sloppy product. This sloppiness, after all, is visible only to one who has a scanning electron microscope which he can turn up to a thousand time magnification. The MSI product serves the same goal, serves it in the same way, and in fact, as the language is used in the Pall patent, it infringes it. It's skinless. But there's no doubt that it looks different.

With respect to the Pall patent itself, references to skinlessness which are significant here, skin is mentioned in Column 2 at Lines 10 through 24 and the skin that it's suggested you're trying to avoid is an exceedingly thin but relatively dense barrier layer, or, quote, skin, close quote, from about one-tenth to five microns thickness of a microporous polymer in which an average pore diameter is in the millimicron range, for example, from one to one-thousand millimicrons, that is, about one-tenth to one hundredth the thickness of the skin.

Now, looking at the MSI membranes it's true they have this exceedingly thin surface area, but I do not find that it is a relatively dense barrier layer. Rather, I find that it is permeated by hundreds of thousands, millions of tiny pores roughly the same size as the pores in the rest of the membrane. That's how skin is referred to in the same way in Column 9 at Lines 44 to 47.

I do not find that the surface pores in the MSI membrane, the micropores in the MSI membrane are of a substantially smaller diameter than the micropores in the remainder of the membrane. The same definition is used in Column 1 at Lines 49 through 53. In Column 2, Lines 32 through 34, there is a reference to an abrupt transition from skin to support layer. Well, now here there is a transition in MSI from what I see on the surface to the interior. But I'm satisfied that on MSI membranes there are pores that are

substantially the same size which are through pores which go from one side of the membrane to the other. Again, in terms of its function, where the Pall patent speaks of skinned membranes exhibiting relatively higher pressure drop and other pore filtration characteristics, here MSI membranes perform as relatively adequate skinless membranes. I find, as fact, that MSI's membranes are skinless within the meaning of the Pall patent and its claims. There is no evidence that persuades this Court of any fluid-blocking layer on MSI's membranes, nor of pinholes or other defects rendering them incapable of performing as microporous membranes. Indeed, the MSI product literature indicates that MSI's membranes have uniform pore structures and are thus skinless within the meaning of the Pall patent. MSI's own descriptions of its membranes include, quote, highly uniform membrane, close quote, quote, uniform uniform, close quote, quote, highly porous, close quote, quote, precise porosity, close quote, and, quote, superior bubble point uniformity, close quote. MSI's own document evidence that a porous structure indicates the absence of skinning as does a uniform pore structure.

These functional aspects can be further explicated, as follows. A bubble point is the pressure that has to be applied to a membrane whose pores have been filled with water in order to replace the water from the first pore. The bubble point is an indication of the largest pore present in a membrane. As that pore releases the water within it the smaller pores do. Thus, the larger the bubble point the smaller the pores in the membrane. MSI also employs flow time to rate its membranes. Flow time is the time required for a certain amount of water to pass through a given area of membrane. The smaller the pores in the membrane the longer or higher the flow time. Very high flow times for particular bubble points indicate skinned membranes. The

relationship between pore size, bubble point and flow time for MSI membranes is in keeping with requested finding of fact 34 and I will incorporate it.

The bubble points of Pall membranes made in accordance with the patent-in-suit are similar to those of the MSI membranes for similar pore sizes. MSI membranes are stated in MSI publications to have a narrow and uniform pore size distribution. This is a characteristic of skinless membraness. MSI membranes, interestingly, have flow times that are frequently comparable and sometimes even better than skinless Pall membranes, and I incorporate the data as requested in requested finding of fact 38.

Not the least of these, the facts upon which these facts and the ultimate conclusion that Pall's -- strike that -- that MSI's nylon membranes are skinless, is that they compete with Pall's in many areas that require skinless membranes, such as filtration and microfiltration and biotechnical applications.

It's clear that MSI considered skinned membranes to have undesirable performance qualities, and I'll incorporate the references in requested finding of fact 44 from the various trial exhibits. And that MSI sought to develop a product that was not a skinned membrane. They've advertised such a product. It competes with the Pall product. I'm not persuaded that they now say, charged with the patent infringement, that it is skinless -- that it is skinned.

MSI's Nylon 66 membranes are alcohol-insoluble, and the resins from which they are made with respect to Nylon 66 is likewise insoluble.

Since I've found that the definition of hydrophobic as used in the Pall patent is definite and understanding, using that definition, I find that Nylon 66 has a contact angle of between 70 and 80 degrees -- for these purposes I'll include 46 -- 46 has a contact angle of 45 degrees, so

under the general definition Nylon 46 is more hydrophilic than is Nylon 66, which would be marginally hydrophilic. However, under the Pall definition both nylons are clearly hydrophobic.

There's no dispute that MSI has employed Nylon 66 and presently employs Nylon 46 and for some applications 66 as the resins from which it makes its membranes. Nylon 66 has a methylene to amide ratio of five, Nylon 46 has a methylene to amide ratio of four. MSI's Nylon 66 membranes are capable when completely immersed in water of being wetted through within no more than one second.

Now, there's been a great deal of dispute with respect to this so-called reversion feature which is part of the claims of the Pall patent. This Court concludes that MSI's Nylon 66 when heated to slightly below its melting point in fact reverts such that thereafter it is not capable throughout the entire surface so that each, that at least part of the membrane surface is not capable of being wetted within one second throughout the entire surface. So in that sense it is directly infringing. The Court concludes that the chemistry, the chemical analysis which explains this aspect of the properties of both the Pall and the MSI Nylon 66 membrane are not well understood and I can make no particular scientific findings thereon. But the membranes react sufficiently similar that the one infringes the other. MSI infringes Pall in that respect. At least parts of the membrane when heated close to the melting point no longer allow the surface to be instantaneously wettable. It's fair to point out, though, that the membranes in this aspect, the comparison of the Pall and the MSI membranes are not completely congruent. It would appear from the experimental data that when heated close to its melting point a Pall membrane is no longer hydrophilic as Pall defines it throughout much or all of its surface, whereas it

appears that the MSI membrane may be wettable throughout part of the surface but not wettable throughout all of it. The point is a close one, but I think that the MSI membrane, the 66 membrane in fact infringes in that regard.

MSI's product literature indicates and the Court finds that most of the MSI membranes, and they're all intended to, have absolute particle removal ratings of .1 to .20 microns. MSI terms its absolute particle removal rating is the -- strike that. The term absolute particle removal rating as used in the patent claims is synonymous with MSI's pore size rating used in its trade literature. MSI's membranes are about one-tenth of a micron to two-tenths of a micron thick and its nylon membrane product literature indicates thickness from 80 to 125 microns. That is .08 to .125 millimicron. MSI's membranes thus meet all the elements of Claims 48 and 132 of the Pall patent in suit.

It's one o'clock. I'm going to stop at this stage and we'll resume here tomorrow. As difficult as this is for you, and I don't do this just to hear myself talk but because I think this is an efficient way to move the litigation along rapidly, that you should hear it and be able to act on it so you are going to have to endure me for the first part of the morning. I don't think I will be longer than, now you can see my estimates as to time, I'll be ready to go at nine o'clock, and I think I'll be done by the break. Whenever I'm done, we'll take a break. And then I want to start with, you'll have the full picture with respect to at least what's in issue with respect to damages when I'm done, and I'll expect to hear witnesses with respect to it.

I expect you're going to call -- let me shift gears now. You've got the fellow who I have his direct testimony and you're going to put on him, Mr. Hartmann?

MR. PHELPS: Well, Mr. --

THE COURT: You may speak to it?

MR. PHELPS: Mr. Petrand is our accounting expert.

THE COURT: Right.

PROCEEDINGS

THE COURT: Good morning, counsel.

MR. HARTMANN: Good morning, your Honor.

THE COURT: Once again, I must apologize for delaying the start of the proceedings. I do so because we are honored this morning to have two representatives of the Laos People's Democratic Republic, and they are Siousavath Songvilay and Thong Phaumnathep, and they are from the Ministry of Economic Planning and Finance. And they are accompanied by Mr. Jeff Hoberman, a law student at Harvard Law School. Their hope was to see a jury trial, and they were over before Judge Woodlock to see such a trial, but his trial settled. And meaning no disrespect to you, we are second best.

This is not a jury trial, and it is in a phase that is somewhat atypical, and I've explained to them that I am now explaining to you the findings and rulings, and let's continue.

Dealing with the filter out element, MSI's cartridge elements contain membrane formed in tubular configuration. The tube is sealed to the end caps. One of the end caps of the filter element has an opening or a central aperture which gives access to the interior of the filter element, and all seals are sealed tight.

MSI's product literature indicates that its filter cartridges are fluid type when it states that its cartridges are integrity tested, because only fluid-type cartridges can be integrity tested with water. SMI's filter cartridges, containing nylon membrane, meet all the elements of claims 49 and 133 of the Pall patent-in-suit. MSI's filter elements, the cartridges, contain corrugated nylon membrane sheets. Filter elements containing corrugated

nylon membranes are important to the filtration industry because they permit increased amounts of membrane to be enclosed in the cartridge. MSI's filter elements, containing nylon membrane, meet all the elements of Claims 50 and 134 of the Pall patent. The end caps in MSI's filter elements are made from the polyester, polybutylene terephtalate, also known as polybutylene glycol terephtalate, or PBT.

MSI first started using PBT end caps in 1983 or early 1984. The MSI filter elements, containing nylon membrane, including the end caps, are hydrophilic, as that term is used in the Pall patent, and rapidly wetted by water, and are, therefore, integrity testable. MSI's filter elements, containing nylon membrane, meet all the elements of claims 55 and 56, and 139 and 140. Less there be any mistake here, I'm carrying on, and these findings relate only to -- or these findings do not cover the claims with respect to Nylon 46.

Let's turn now to the process claims.

(Pause).

Take a minute here because I've mislaid it. I want a copy of the diagram of the MSI process.

Does anyone have one handy -- never mind, I just found it. Forgive me.

The Court finds that the Pall process is in various respects -- strike that.

The Court finds that the MSI process is in various respects different from that as set out in the Pall patent. Now, I recognize that the Pall patent does not describe a commercial process, but rather, in patent terms, describes the claims of a process. I think it's necessary to describe the process as used by MSI, so that a comparison can be made to the Pall process claims.

MSI's process involves, first, adding water and then adding powdered citric acid in a tank and mixing it, pouring

off buckets of this material, which are then -- a bucket of the material is added to a mixer, first; then certain carefully premeasured amounts of water, hydrochloric acid, and because these findings are limited to Nylon 66 rather than Nylon 46, Nylon 66 pellets or powder, which are mixed five hours or more and held overnight. The mixture, which I will call a lacquer, is then poured into a lacquer holding tank which is movable and which can be held from zero to 24 hours until needed.

The lacquer holding tank is then pumped at 4 ounces per minute through a heater tube, one half-inch in diameter by four feet, and it passes then through a clear plastic pipe through a 75 micron filter, originally through a 25 micron filter, though that's no longer used, then into a static mixture. The lacquer is then delivered onto the support web, which is rolled off a roll through a coating mechanism, referred to as a knife box, into a nonsolvent immersion bath, then into a water rinse, and, finally, at a rate of two to four feet per minute into a drier, where it's exposed to drying at 350 degrees Fahrenheit of hot air and then the finished filter is wrapped onto a spool.

More specifically, the formulation of the lacquer contains a mixture of solvents and a nonsolvent at a ratio of nylon 12 percent, hydrochloric acid 8 percent, citric acid 60 percent, and water 20 percent. The solvent action of the hydrochloric acid is boosted by the citric acid during the portion of the period in which MSI has been in production for certain applications, MSI has employed formic acid as the solvent. Formic acid is the solvent preferred in the Pall patent. Water is the nonsolvent in the casting resin. The Pall patent examples employ 13 percent nylon between a solvent of between 66 and 71 percent formic acid and between 16 and 21 percent nonsolvent water.

Now, the Court does find that MSI nucleates its nylon lacquer solution by controlling the initial mixing

measurement, the concentration of the reagents and, subsequently, the lacquer temperature and degree of agitation. Because the lacquer -- because the solvent used in the MSI formulation is hycrochloric acid, however, the lacquer does not gel anywhere near as fast as the comparable lacquer solution used by Pall. Indeed, the MSI lacquer can be maintained in commercially acceptable fashion overnight. MSI controls the mixing regimen for the initial solution by setting the mixing speed at 90 rpm. MSI has come to understand that temperature is a significant variable and the temperature of the nylon solution is initially controlled at a set temperature of 35 degrees centigrade. After mixing, the lacquer is pumped through a heat exchanger, which heats it to a particular temperature between 30 degrees and 70 degrees centigrade.

In the MSI process, the pore size is controlled by varying the concentration of the solvent to nonsolvent components in the lacquer by minute amounts, fractions of a percent. The pore size is further controlled by heating the lacquer after it has been initially mixed and then further mixing it in a static mixer while it is being transferred to the casting box. The fact that MSI prepares membranes of different pore size by changing the temperature of the lacquer and without changing the composition indicates that the lacquer is nucleated, as that term is used in the Pall patent.

The Court does not find that the appearance of any visible precipitate as a significant parameter in the MSI process. MSI, however, does recognize the importance of nucleation, as that term is used in the Pall patent, the nucleation of its casting resin on the pore structure of a membrane. That was recognized by MSI in October 1982. That concept is taken form the Pall patent.

It is true that independent testing of the MSI lacquer solution by Pall results in a visible precipitate temporarily

appearing when drops of nonsolvent and water are added to an MSI nylon lacquer, which precipitate then redissolves in the solution. And in testing, this is an indication that the solution has been properly nucleated, but this Court does not find that there is any visible precipitate in the process or any need or concern about a visible precipitate in the process as employed by MSI.

MSI employs filters to filter out undissolved nylon particles and other debris before spreading the casting solution on the support. The MSI process cannot operate successfully without these filters. The MSI process depends in part on heating of the lacquer, which is employed to control the viscosity of the resin. The Pall patent examples disclose heating the casting resin solution between 35 degrees and 70 degrees centigrade, in order to control the lacquer viscosity.

After the casting solution is prepared, a distribution tube spreads the casting solution on the polyester support, which is fed through a knife box to insure that a thin even predetermined thickness of lacquer is spread on a porous support. The support is saturated with -- the support, saturated with the nylon lacquer, is immersed in a nonsolvent bath of citric acid 40 percent and water 60 percent, where the nylon precipitates into a solid membrane. The membrane is then immersed into a wash bath which removes remaining solvent and nonsolvent. The membrane is then dried and rolled up. MSI employs about 40 percent citric acid in its quench bath, along with 60 percent water. The citric acid makes the bath a less strong nonsolvent. It reduces the nonsolvent properties of the water and acts to temper the interaction between the lacquer film and the quench bath, thereby causing precipitation in a uniform consistent manner.

The Pall patent states that 40 percent -- 40, 50 percent solvent in the quench bath is necessary to slow

down the reaction and temper the reaction to prevent skin formation.

The viscosity of MSI's Nylon 66 resin solution is in the range of 1,000 to 3,000 centipoises. The casting and precipitating temperatures of MSI's process are within the range of about 10 degrees centigrade to the boiling temperature of the lowest boiling solvent or nonsolvent component present. Polyester support is not stripped from the membrane before drying, and after drying remains attached to the membrane.

In view of the dependency of all the process claims at issue on process claim 77, this Court does not find direct infringement by MSI of the process claims of the Pall patent, specifically, because it is no part of the MSI process to seek, as is claimed by the Pall patent, "to obtain a visible precipitate of polyamide resin particles." So, there is no direct infringement of the process claims. However, that does not end the analysis, because the Court finds that MSI makes a casting solution which performs substantially the same function in substantially the same way and obtains substantially the same overall result as to the casting solution of claims 1 and 77 and the asserted claims depending thereon. The casting resin which is finally obtained and used is in all significant respects equivalent to the nucleated casting solution of Pall's patent.

The Court finds that MSI set out to design around the Pall patent was at all material times familiar with the Pall patent, intentionally sought to design around that patent; and while -- and there is certainly nothing wrong with that, as the most recent submission of MSI demonstrates.

In this case, with respect to these process claims, MSI by using Nylon 66 has infringed the Pall patent and the process claims thereof, pursuant to the Doctrine of Equivalents. So as to Nylon 66, the Pall patent

stands valid and infringed, directly infringed as to the product claims and infringed under the Doctrine of Equivalents as to the process claims.

Now, let's turn to Nylon 46. By October 1989 MSI was making a commercially acceptable microporous membrane through the use of Nylon 46. MSI had developed this membrane largely in response to the instant lawsuit, out of a desire to avoid liability through the use of its Nylon 66 membrane. By MSI's own admission, there are but minor differences in MSI's process for making Nylon 46 membranes as compared to its process for making Nylon 66 membranes.

Out of order now, I need to go back just a bit to say something further in explanation of why I think the Doctrine of Equivalents applies to the Nylon 66 process.

I found that MSI intended to design around the Pall patent. MSI very well knew the commercial success of the Pall patent, very well knew, understood, and appreciated the substantial advance made by the Pall patent. In essence, from a careful review of these notebooks and through -- I find that what MSI has done has set up what Mr. Hartmann in his closing rightly called a measurements regime, the zest of the art of the learning of the Pall patent, MSI could address the problem of production of microporous nylon membranes using Nylon 66 far more rapidly with less experimentation and in a much different fashion than the original inventor would have to address the problem. And by carefully measuring the components used in the process of making these nylon microporous membranes, MSI developed a process which depended more on the measurements than it did on the steps of the Pall patented process.

This Court finds that the only way, when one could come up with such a measurements process, a measurements regime, as Mr. Hartmann properly referred

to it, is through the learning of the Pall patent. In addition, tested by the Graver Tank standards, all aspects of the Doctrine of Equivalents are met here. The Nylon 66 process infringes by virtue of the Doctrine of Equivalents.

Now, let me get back to Nylon 46.

Nylon 46 is known as polytetramethylene adipamide. It is made from diaminobutane and adipic acid. It is not a polymer of hexamethylene diaminine, diamine, an alaphatic saturated dicarbol -- dicarboxylic acids having from 6 to 10 carbon atoms, as required by the invention of the patent-in-suit. Nylon 46 has a ratio of methylene to amide groups of 4 to 1. It does not have a ratio of 5 to 1 or 7 to 1, as found in Nylon 66 and Nylon 610, respectively, nor does it fall anywhere within the range of 5 to 1 or 7 to 1 methylene to amide groups. Of course, the patent is not limited to 5 to 1 or 7 to 1, as to its ratio of methylene to amide groups. The patent speaks of a ratio of about 5 to 1 to about 7 to 1 methylene to amide groups.

I've already ruled that the term "about" does not, in part, have any validity to the claims of the patent in this respect. Exactitude in claims scope is not required under 35 U.S.C., Section 112, Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, Fed. Circuit (1986), cert. denied, 480 U.S. 947 (1987). The law imposes no obligation on a patent applicant to determine what is going on in a technological gap between the claimed invention and the prior art or to set the claim limits at the precise technological edge of the invention. The claim is not fatally indefinite for failing specifically to delineate the exact point at which the change in physical phenomena occurs. Andrew Corp. v. Gabriel Electronics, Incorporated, 847 F.2d 819, Fed. Cir., cert. denied, 488 U.S. 927 (1988).

Let's stop and let the court reporter change her disk.

(Pause.)

THE COURT: May we be in order.

The term "about" is not an arbitrary term but is a flexible term with a meaning similar to approximately. It is not subject to a precise and universal construction but is, instead, dependent on the facts of a particular case, W. L. Gore & Associates, 842 F.2d 1275, 1280, Fed. Cir. (1988), Amgen, Incorporated v. Chugai Pharmaceutical Co., Ltd., No. 90-1273 through 1275 Federal Circuit (1991). And I may expand on this "about" legal reasoning because I've gone through these cases with some care, and I will incorporate other cases in the analysis as I reflect on this. Even so, the Court finds that Nylon 46 is not within the range of about 5 to 1 to about 7 to 1. The ratio of methylene to amide groups of 4 to 1 has some chemical properties that are of marginal difference.

The fair English reading of the language is such that it strains to reach to place Nylon 46 within the range of about 5 to 1 to about 7 to 1. I do not so find Nylon 46 either in the product or in the patent claims does not literally infringe the claims of the Pall patent. Since there is no literal infringement, Pall must show that the claims of the patent are entitled to the application of the Doctrine of Equivalents before Nylon 46 can be held to infringe the Pall patent.

The decision of the Court of Appeals for the Federal Circuit, in Slim-Fold Manufacturing, Incorporated versus Kincade Industries, Incorporated, is pertinent on this point. That's Appeal No. 90-1416 through 1429, slip opinion, the Federal Circuit, May 15, 1991. As Judge Rich said there, Intentional designing around the claims of a patent is not by itself a wrong which must be compensated by invocation of the Doctrine of Equivalents. Designing around patents is, in fact, one of the ways in which the patent system works to the advantage of the public in

promoting progress in the useful arts, its constitutional purpose. That's the slip opinion at pages 6 and 7.

Judge Rich goes on to say that it is only when the changes are so insubstantial as to result in a fraud on a patent that the application of the Doctrine of Equivalents becomes desirable. Following the analysis in Slim-Fold, the first question which must be asked, Has a substantial change been made? Only if the answer to that question is no should an accused infringer be liable for improperly trying to appropriate the claimed invention. And again following Judge Rich's analysis, this is where the Graver Tank tripartite test comes into play. The differences between an accused device and an acclaimed device are considered to be insubstantial only when the accused device performs substantially the same function in substantially the same way to achieve substantially the same result as the claimed device. The determination of whether an accused device meets this strict test is one of fact. And I find as fact that Nylon 46, as used by MSI, does in fact perform substantially the same function as nylons in the range of about 5 to 1 to about 7 to 1. It performs it in substantially the same way to achieve substantially the same result as the claimed device. Indeed, MSI in its advertising doesn't even point out the source of the nylon used, and claims themselves that they do precisely the same thing.

The Graver Tank Doctrine of Equivalents and its tripartite test is met. The differences between the accused device and acclaimed device are insubstantial. The question of whether a substantial change has been made by switching to nylon 46 is no. And so, we go on to consider whether the Nylon 46, which the Court finds does infringe the Pall patent under the doctrine of Equivalents, can be held so to infringe, in light of file wrapper or file history estoppel.

It's very clear that file wrapper estoppel bars recourse to the Doctrine of Equivalents in cases where the patentee attempts to secure through equivalents what has been rejected by the Patent Office. It prevents application of the Doctrine of Equivalents to recapture coverage which the patentee has surrendered by amendment whether or not the prior art required the amendment. That's from Carter Products, Incorporated, Colgate-Palmolive Company, 269 F.2nd 299 at 304, Fourth Circuit (1959), and cases there cited.

See also Oregon Chain Saw Corporation v. McCullough Motors Corporation, 323 F.2nd 758 at 768, Ninth Circuit, (1963). The citation just made, the Fourth Circuit decision, points out that the -- it is not germane to consider whether what was surrendered was surrendered by virtue of the prior art or not. Now, that has not been the view of all the circuits. Specifically, in Bishman Manufacturing Co. v. Stewart Warner Corporation, 380 F.2nd 336, 340, Seventh Circuit, 1967, the Court held that a necessary condition for the establishment of a file wrapper estoppel is that the patentee must have narrowed his claim in response to an objection by the Patent Office in order to obtain the patent.

To the same result, or along the same lines, is the case of Trio Process Corporation v. L. Goldstein Sons, 461 F.2nd 66, 75, Third Circuit (1972). There, the Court held that the doctrine of file wrapper estoppel is based on the theory that the prior art is either in the public domain or already patented, so that the patentee may not claim it as part of his invention by redrafting or abandoning a claim in the face of a prior art rejection, the patentee is conceding that he has not invented what he thereby disclaims, and therefore will not be heard to assert at a later date what he disclaimed as his invention. Accordingly, for file wrapper estoppel to become operable, it is necessary at

the least, that a claim have been narrowed to avoid the prior art. Citation submitted.

Here, the claims were redrafted, not because they trespassed upon the prior art, but because they were considered misdescriptive in view of the specification of the patent. The rejection here was a technical matter, based upon the rules of practice of the Patent Office, and had nothing to do with the question of whether the matter rejected was patentable. In such a situation, it would not be equitable to deprive a patentee of the full fruits of his invention because of a formalistic rule of the Patent Office.

Trio Products -- Trio Process, excuse me, is frequently cited. It's cited in this circuit in Polaroid v. Kodak, though not for that proposition, and remains good law.

The law, however, in the First Circuit is to the contrary. The First Circuit joins in with the Fourth and the Ninth. It's probably inappropriate to say it joins with the Fourth and the Ninth because the First Circuit was the First Circuit that I've been able -- the Section Circuit, Fourth Circuit in '59 was the first I've been able to find. The First Circuit, speaking through Chief Judge Aldrich, a most distinguished jurist and an expert in patent matters, said in Borg-Warner Corporation versus Paragon Gear Works, Incorporated, 355 F.2nd 400 at 406, First Circuit (1965), in dictum, the following:

In our opinion, the determinative factor as to whether file wrapper estoppel ought apply, should not be the reason why a change was required by the Patent Office, but what in fact was surrendered.

Skipping some case specific discussion in Borg-Warner, it should make no difference whether the reason was an alleged conflict with prior art or alleged insufficient definiteness. In either event, a subsequent party examining the file to make sure that his own device,

omitting references to the case specific data there, would not infringe, would discover that so broad a scope had been affirmatively disclaimed. The patentee, in Borg-Warner then, accordingly, should be estopped to recapture it.

Now, this dispute between the First, Fourth and Ninth and the Seventh and Third Circuits, causes this Court some real problem, because there would be no problem, I guess, I'm clear, if the -- no problem with the dispute between the First, Fourth and Ninth Circuits, on one hand, and the Seventh and Third Circuits, on another, because this Court sits in the First Circuit, and I'm bound by what the First Circuit has to say. Unfortunately -- or not unfortunately, the matter is now not a matter which is within the jurisdiction of the First Circuit or any of the numbered circuits, but rather it's within the jurisdiction of the Federal Circuit. And the Federal Circuit has spoken to the issue in Bayer Aktiengesellschaft versus Duphar International Research, 738 F.2d 1237 at 1242, and earlier in Hughes Aircraft Company v. United States, 717 F.2d 1351 at 1362, Federal Circuit (1983).

In Hughes, the Federal Circuit said, some Courts have expressed the view that virtually any amendment of the claims affects, creates a file wrapper estoppel effective to bar all resort to the Doctrine of Equivalents and confine patentee strictly to the letter of the limited claims granted. We, as had the Supreme Court, reject that view as a wooden application of estoppel, amendment of claims is a common practice in the prosecution of a patent applications. Amendments may be of different types and may serve different functions, depending on the nature and purpose of the amendment, it may have a limiting effect within a spectrum ranging from great to small to zero. And then in Bayer Aktiengesellschaft, they say, specifically, thus, whenever the doctrine of file history estoppel is invoked, a close examination must be made as to not only

what was surrendered but also the reason for such a surrender. The fact that claims were narrowed does not always mean that the doctrine of file history estoppel completely prohibits the patentee from recapturing some of what was originally claimed.

Accordingly, limiting the claims because of a restriction requirement, as appeared here, would not necessarily invoke file history estoppel.

I take that decision as governing the analysis in this case, notwithstanding the dispute in the circuits and the decision of the First Circuit in Borg-Warner. To this same effect, see also Anchor Plastics Company, Incorporated versus Dynex Industrial Plastics Corp, 363 F. Supp. 582, 605, District of New Jersey (1973).

Moreover, for the analysis followed by this Court here, reference also should fairly be made to Johnson and Johnson v. W.L. Gore & Associates, 463 F. Supp. 704, District of Delaware (1977), and I'll include the subsequent history of that case. There, too, the Court found that the claims of the patent were not literally infringed, as is the case here, but applied to the Doctrine of Equivalents, as is the case here. I cite from this Johnson and Johnson decision on page 730, the language, the fact that the expanded lower density tape was unknown at the time of the application for the patent-in-suit does not render the Doctrine of Equivalents inapplicable.

For infringement, the equivalent need not have been known at the time of the invention. And I take that as good law; as, further, I take it good law that it is well established that an inventor is entitled to whatever merits his invention has, even though they may be greater than he supposed.

I find that Nylon 46 was known to people experienced as chemists in the area of nylon polymers. Its chemical properties were known. Its methyl -- methylene to amide ratio was known. What was -- I also find that it

was not commercially available, no one was making it, and -- at least for commercial purposes. And having in mind that be the patentee here, Pall, does not have to experiment with every possible combination for purposes of Pall's claiming the Pall invention, I do not find that Nylon 46 was known, in the sense that there was any requirement that Pall experiment with Nylon 46 to understand its properties.

So, there's no literal infringement. The Doctrine of Equivalents applies, unless file history or file wrapper estoppel prevents its application here. So, we are led back to the findings the Court has already made concerning the file history, and I've made some fairly extensive findings.

Based upon these findings, the Court finds this fact that Pall in limiting its claims, in responses to the overbreadth concerns of the patent examiner, never gave up a claim to Nylon 46. Pall's own experiments indicated the expected range of its -- the validity of its invention, but the use of the term "about," which is an appropriate term, is indicative that Pall was not surrendering the invention down to the limits 5 to 1 to 7 to 1. As a matter of fact, Pall never intended to abandon and did not abandon its claim to workable nylon polymers which fall outside the range of 5 to 1 to 7 to 1, so long as, arguably, they are within the range -- or, within the penumbra of combinations which are about that range.

Accordingly, the Court finds that although there is no literal infringement in this case, given its peculiar facts, the Doctrine of Equivalents is not trumped or made inapplicable by the file wrapper history. Therefore, since Nylon 46 infringes the Pall patent under the Doctrine of Equivalents, that patent, even as to Nylon 46, is valid and infringed; and MSI is forthwith, its agents, servants, and counsel, and all persons acting in concert therewith, are enjoined immediately from any further production or sale

of any items involving Nylon 46 to the same extent that the Court has already enjoined Nylon 66.

Now, the next matter the Court must consider is the matter of MSI's willfulness in the conduct in which it has been engaged here.

Willfulness must be proved by clear and convincing evidence in order to justify increased damages under 35 U.S.C., Section 44, E.I. Du Pont de Nemours, and Phillips Petroleum Company., 839 F.2d 440, Federal Circuit (1988). This determination is to be made on the basis of the totality of the circumstances, if it has been shown that the infringer had no reasonable basis for believing it had a right to do the acts, Stickle v. Heublein, Incorporated, 716 F.2d 1550, 1565.

In the filings that the Court has made in this case, and recognizing that MSI has intentionally sought to design around the Pall patent but has made extraordinarily extensive use of that patent in its own process, having in mind that counsel was not consulted to give an opinion about the infringement or lack thereof, this case would appear to be a candidate for increased damages based on willfulness. Nevertheless, the Court finds that in the main, the Court rules, is the proper way, in the main there ought not be any increased damages for willfulness here, and I reach that result to the following analysis.

First, I'm not terribly troubled by the failure to consult counsel. These are people experienced in the industry. I see no reason that counsel has a monopoly knowledge about these matters. I don't think someone should be penalized simply because they didn't go to counsel. I think they made significant efforts to avoid the claims of the patent. They have avoided the process claims. They have avoided the product and process claims, so far as Nylon 46 goes, and they are liable only through the Doctrine of Equivalents.

What's more, the application of the Doctrine of Equivalents here as to the process claims, both as to Nylon 66 and 46, is not free from doubt. The matter is a complex matter on which the Court has taken a great deal of thought. And taking all those things into account, I decline, I do not find in the main that there is any -- that there should be any increased damages with respect to willfulness.

There is this exception. In October 1989, MSI began producing its product line, apparently, primarily using Nylon 46, a product which I've already found it developed to avoid the patent. What's more, it produced -- or it switched to Nylon 46 during the course of vigorous and active litigation in this case, during a period when it's clear that it was advised by competent and knowledgeable patent counsel. That being so, the evidence indicating further that even after it switched to Nylon 46, on occasion it continued to manufacture items using Nylon 66.

The Court accordingly rules, as it must have been apparent to MSI by October 1989, given its extensive research efforts, its involvement of patent counsel, that Nylon 66 violated the patent-in-suit, infringed the product claims of the patent-in-suit. To that extent, the extent that after October 1989 MSI has manufactured anything using Nylon 66, the damages that stem from such manufacture are declared to be willful.

Now, as MSI points out, in cases where willfulness is found, whether or not increased damages should be awarded is a separate and distinct determination which I can make only after I've heard the damages case. But I -- and I'll say no more about it, other than the proof of damages may include proof of whatever was made by Nylon 66 -- or with Nylon 66 after October 1989.

Now, attorneys' fees, the award of attorneys' fees under the patent law is reserved for those exceptional cases where there has been conduct so egregious that as an

equitable matter, the award of attorneys' fees is appropriate. While the matter is within the discretion of the Court, such discretion may be exercised only upon a specific finding of exceptional circumstances. Such circumstances may consist of inequitable conduct by -- of a party in pursuing the litigation. Indeed, there are cases which hold that attorneys' fees may be awarded in exceptional circumstances for inequitable conduct in the manner of conducting the litigation.

And with respect to the nondisclosure of the use of Nylon 46, wholly apart from the Court's supervisory -- wholly apart from the Court's sanctions under the Federal Rules of Civil Procedure, this Court finds that this case is an extraordinary case because the Court finds that faced by clear requests for discovery of the use of Nylon 46 MSI, nevertheless, refused to make discovery, concealed that fact, indeed, by making discovery which did not go so far as to disclose the use of Nylon 46, a matter which was disclosed only at the time of trial.

That being so, attorneys' fees are awarded to Pall, so much of its attorneys' fees as are addressed to the prosecution of the case solely against Nylon 46, once that was discovered. Of course, how much those are will await the damages case. Such attorneys' fees, of course, may be ordered only against the litigant, and they are so ordered, not against the attorneys. And it will be clear that my sanctions, in light of 46, go against the attorneys as well, but not under the patent laws because the patent laws don't go that far.

Now, that pretty much concludes the Court's findings of fact. Recognizing the difficulty of declaring these facts from the bench, I may have a few other odds and ends out of order, and let me look over my notes in that respect, and I can integrate these should I do a further draft in the future.

(Pause.)

It's clear that Pall makes no claim as against skinned membranes. Figure 8 in the patent shows a skinned membrane, which is outside the range of the patent. The introduced no new matter. It's clear to this Court that Pall tried to design the Marinaccio patent, just as MSI tried to design around the Pall patent. Indeed, Pall focused heavy resources on designing around the Marinaccio patent. Pall, however, did it successfully.

A Markush claim is a claim in which a group of related things -- strike that. A Markush claim claims a group of related things of which examples are given. MSI uses Nylon 46 presently and uses it in -- the original source of Nylon 46 in its process is a Nylon 46 powder to make their commercial product. It's clear from the development plan of MSI that from the very beginning MSI planned to compete with the Pall 66 cartridge, but to undercut it by price. Pall's products were considered. Competition with Pall was one of the goals of MSI from the very beginning. And with that in light -- in light of that, the corporate decision was made to make a nylon membrane from Nylon 66 that would be readily wettable.

The Pall method of nucleation is one of the keys to its patent. It's vital for commercial repetition of the quality. It's equally clear that if the nucleation is done differently, the Pall patent is not infringed.

Zytel 101, the commercial source from which Nylon 66 is used by MSI, is hydrophobic, as that term is used in the Pall patent, that is, it does not have a zero contact angle; it's not readily wettable by water in approximately a second.

Cuno restarted its membrane program in 1978 after seeing a Pall sample. MSI advertises membranes to fit the Pall housing with fin and bayonet lock, and expressly makes seals that will fit the Pall housing. MSI has

published various advertising materials in advance of the actual development; and then, indeed, the MSI materials could not pass the tests and has not made significant sales to the pharmaceutical industry, and notwithstanding advertisements which say those tests were passed.

The MSI membrane with its surface configuration, which I have held is not skinned, in light of the Pall patent claims, nevertheless, appears better than the Pall patent for those DNA transfers involving blotting. And this is because there's more polymer at the surface to hold the DNA. Nylon 46 has a contact angle of 45 degrees; and, is therefore, under the general definitions, more hydrophilic than the nylon polymers used by Pall, but it is hydrophobic as those terms are used in the Pall patent.

Pall was the first person to work with a highly crystalline material and wind up with a reproducible membrane of uniform pore size. Though Nylon 6 is included within the patent claims of the Pall patent, it is -- Pall does not commercially manufacture anything using Nylon 6.

Marinaccio's patent claims polystyrene as a workable substance. In fact, polystyrene can never be made into a membrane with a zero contact angle which meets the definition of hydrophilic, as the term is used in the Pall patent. Marinaccio did not distinguish between amorphous and crystalline polymers.

The manufacture of Nylon 46 commercially commenced approximately May 1984, when Dutch State Mines revealed that they were going to introduce a new commercial polymer, Nylon 46. There are differences between Nylon 46 and Nylon 66. Nylon 66 has a melting point of 260 degrees. Nylon 46 has a melting point of 290 degrees. Nylon 46 is more hydrophilic, as the term is generally used, than the other polymers discussed in this opinion.

In the MSI membranes, there are more crystallinity on the surface than in the interior. In the MSI product, the web, the polyester web, makes up about 75 percent of the membrane thickness. It's melting point is 270 degrees centigrade. Nylon 46 was known, at least theoretically, since 1942 to chemists and chemical engineers.

All right. Those are the findings of fact and rulings of law on the liability case. I propose to recess until 5 minutes of 12 and continue with the damages case. Before I do so, I am going to ask for questions.

Now, my questions are not about procedures and they're not so that I can be examined with respect to alleged inconsistencies or errors or whatever with respect to my findings and rulings, but I welcome, as I said before, I welcome written memoranda which point those matters out and also written memoranda that, once you've got the transcripts -- you have the first part of the transcript, as you're ordering daily copy here -- which detail the transcripts, the exhibits, and any other legal references with respect to the specific findings and rulings made. So if you agree to do it, I welcome it.

Really, I want to know about procedure because we're working together. Any questions now about what we'll do after the recess?

Mr. Hartmann.

MR. HARTMANN: No, Judge, I have a question about next week's schedule.

THE COURT: We'll take it up at the end of day.

MR. HUETTNER: And Ms. Shea has some motions, your Honor, which we can present after the recess.

Devex; specifically stands for the proposition we say that it is not restricted to exceptional circumstance. On the contrary, prejudgment interest should ordinarily be awarded absent some justification for withholding such an award.

So we think the presumption is that the interest be awarded.

THE COURT: Thank you.

Here's what consistent with the rules I think it's appropriate for me to say at this time.

The case has been broken up for trial in phases. We're now in the damages phase of the jury waived case. The plaintiff has now completed its presentation of damages evidence. The Court on its own motion has entertained argument to see whether there are any limitations on recovery which commend themselves to the Court's good judgment having heard and evaluated the evidence that is received. And there are. I'm going to talk these matters through. It will be clear when I'm done that there remain matters to which MSI may wish to present evidence, but there are limits beyond which I am not persuaded on the best case presented by Pall that a finding is supportable.

As a general matter, the Court approaches this issue, subject to MSI's presentation of evidence, by a calculation of lost profits, a separate calculation of a reasonable royalty, a calculation of this blend, though not, I cannot now rule that a blend is appropriate, and a comment about attorneys' fees.

In each case, I think the rule as it relates, the rule of civil procedure as it relates to the findings and rulings that can be made at this point contemplates that courts may in a lengthy case such as this set these limits even though I cannot now say, and I do not say, that any of these approaches have not been proved.

So, first, as to lost profits, I'm going to go through the variables that seem to me to bear on the issue.

It appears that the MSI sales figures for the years in question appear prima facie to be proved and form, at least at this stage of the case, a reliable basis for calculation. The Court rules that Pall's penetration of the MSI market, all things considered, would not have exceeded 25 percent of MSI's sales. I make that ruling based upon my understanding of Cuno's activity in the market. Make no mistake. This business of excluding the evidence as to Cuno is significant. I think Cuno's in the market. In fact, it may be something less than 25 percent, or it may rise to 25 percent over the years, but I don't think the, I don't think the, given the price differential of Pall's products, the availability of other substitutes with respect to the nylon microporous membrane market, Cuno's activities in the field, that their penetration would, as of 1991, exceed 25 percent of what MSI was selling.

I largely adopt the process that Mr., or I do as a prima facie matter, because there seems to be not much dispute about it, the process that Mr. Petran used to calculate the lost profits, but I think the penetration would not have exceeded 25 percent, not a hundred percent. I also think that the variable with respect to the profits of Pall as compared to the profits of MSI to the, make the adjustment there, would not exceed 45 percent. To that extent, I have problems with and reject certain of the testimony as to the actual costs of Pall, Mr. Petran's evaluation of those costs and the like. But using those figures, the economic model is appropriate, it seems to me, and those would seem to me to be the appropriate limits. It seems to me that prejudgment interest in the manner that it has been calculated in the Pall report is entirely appropriate and prima facie.

Now, that's as to lost profits.

As to royalties, again the sales figures at present stand impugned. A royalty, a reasonable royalty rate on the evidence I have received would not exceed eight percent it seems to me. Conceivably it's lower, but it would not exceed the hypothetical eight percent.

The business about blending the two seems to me to be unimpugned on this record and, naturally, the attorneys' fees are unimpugned on this record. I do not reject as matter of law the approach to calculation of the attorneys' fees. It seems to me logical and acceptable. Of course, it has not been tested by the defense case and the defense is open to test it.

So that's about all I can say at the present time. There will be damages, I can't see them exceeding the limits that I have stated, and we'll turn to the defense case.

Let me say something, though, so that you're all very clear as to what's going to happen. I would imagine that MSI, though this case is, has not turned out as they would have hoped, is terribly eager for final judgment in this case so that they can get beyond this Court to the Court of Appeals.

Now, you've got until, an hour and ten minutes now, you've got from 9:00 to 1:00 tomorrow, and if we're not done tomorrow, then I will fit you in when I can in the afternoon. The complete inaccuracy of any reasonable estimate as to how this case was to be tried to me requires that I now get on to my other cases and I'll fit in this case when I can.

Now, there will be no final judgment, of course, upon, Dr. Kesting and others of our experts, including Mr. Petran whose fees have been criticized. They were called on expressly to get on top of the Nylon 46 situation, and we think that under the circumstances their fees are all reasonable.

Thank you, your Honor.

THE COURT: All right. I have to meet with the clerk now, and also I am going to reflect on whether there is anything I can say about this case at this point. I think there are some things I can say, and so we'll recess until 11:00. If I keep you waiting a little longer than that, please bear with me, because I think we should meet after 11, and we'll see where we stand.

Yes, Mr. Phelps.

MR. PHELPS: I will note that a motion was handed up this morning, you hadn't acknowledged it on the record, and I want to be sure that you have it. It's called, Plaintiff Pall Corporation's Motion to Add Trustee and Reach and Apply Defendants and for Injunctive Relief.

THE COURT: I didn't acknowledge it, and I now do, and I'll take a look at it. All right. We'll recess at least until 11. We'll recess.

(Recess taken.)

THE COURT: I think that I can talk my way through to judgment in this case. I make all the reservations that I made earlier when I was making findings and rulings with respect to liability. Precisely, or more specifically, in this aspect of the case, I reserve the right to find additional subsidiary facts fleshing out the more general findings of fact that I make at this time. I should also say that the, I won't call it untimely filing, I'm happy to have it, but I have not had a chance to reflect on the proposed findings of fact suggested by Pall. I will do so, but I am sufficiently clear from my review of the transcripts, my own notes, and conduct of the case, with matters all fresh in my mind, that I am able, it seems to me, to make the appropriate findings that lead, as to monetary liability, lead to judgment.

There is one loose end that I have not specifically pinned down, and let me do that now.

The failure to make disclosure relative to Nylon 46 has been the subject of an order of sanctions by this Court, an order which was later modified to exclude on the record, and the clear record, Mr. Halpern and Ms. Shea in Boston, and at that time Mr. Huettner pointed out to me that the order was conditioned on Pall failing to get any recovery under nylon, or with respect to Nylon 46, and so it was. And since Pall has and will recover for the infringement which prescinds from the production of these items using Nylon 46, the sanction, though the order stands, the monetary sanction, so far as the order goes, has never come into effect either as against Mr. Huettner nor as against MSI. So on that basis there's no attorneys' fees or sanction to be assessed as against MSI or Mr. Huettner. There will be attorneys' fees assessed under the patent laws due to the failure to disclosure Nylon 46 and the prolongation of the litigation therefor, all as I've earlier explained.

Now, let me turn to what is before the Court, and there are some general findings and rulings of law that are appropriate to be made and I'll make them.

Chapter 35 of the United States Code, Section 284 provides that, in the case of infringement, the patent owner, in this case, Pall, is entitled to an award of damages adequate to compensate the infringement but in no event less than a reasonable royalty for the manufacture, use and sale made of the invention by the infringer, here, MSI. Pall is entitled to interest and costs as fixed by the Court. Pall may recover lost profits if it can show a reasonable probability that, but for the infringement, it would have made the sales that were made by MSI. Beatrice Food v. New England Printing, 899 F.2d, 1171 at 1173, Federal Circuit (1990). To recover lost profits Pall need not negate all possibilities that a purchaser might have brought a different product or might have foregone the purchase

altogether. Paper Converting Machine Co. v. Magna-Graphics Corp., 745 F.2d 11 at 21, Federal Circuit (1984).

In order to recover lost profits Pall must show: (1) a demand for the patented product; (2) the absence of acceptable noninfringing substitutes; (3) manufacturing and marketing capability to exploit the demand; and (4) the amount of profit it would have made. Panduit Corporation v. Stahlin Bros. Fibre Works, Incorporated, 575 F.2d 1152, 1156, Sixth Circuit (1978).

This method of proof, also called the Panduit test, has been accepted by the Court of Appeals for the Federal Circuit. Bio-Rad Laboratories v. Nicolet Instrument Corp., 739 F.2d 604 at 616, the Federal Circuit, cert. denied, 469 U.S. 1038 (1984).

As part of the lost profits analysis courts rely on what has become known as the incremental income approach. Paper Converting Machine Co. v. Magna-Graphics Corp., 745 F.2d 11 at 22, Federal Circuit (1984), and that approach has been adopted by my colleague, Judge Harrington, in this district in King Instrument Corp. v. Parego, 737 F.Supp. 1227 at 1242, District of Massachusetts (1990). This Court is not bound to follow the analysis of another judge in the district, but the Court is not inclined to reinvent the wheel, as well, and where there is a persuasive analysis of a point by one's colleague in the same district, matters of comity and equality among litigants, as Judge Wyzanski put it in his article on judging, strongly incline toward the Court following the same analysis, and this Court does so.

Likewise, turning to -- well, enough said about lost profits.

The Court, in this case, is going to calculate both lost profits and a reasonable royalty and is going to, for each of the years in question, calculate a blend of the two. In calculating a reasonable royalty the Court follows the

criteria set forth in Georgia-Pacific Corp. v. U.S. Plywood Corp., 318 F.Supp. 1116, Southern District of New York (1970), modified, 446 F.2d 295, Second Circuit, cert. denied, 404 U.S. 870 (1971). Most specifically, the fifteen factors relevant to a determination of a reasonable royalty all have been considered by the Court here.

Now, that said, the Court can turn to making some specific findings, and in terms of organization of these findings the Court will work from the spreadsheet initially submitted by Pall which reflects what Pall calls the Judge Young 6-19-91 scenario, and I'll make alterations to the data set forth there and the assumptions set forth there as is necessary.

First, I'm satisfied that the material time in question includes the fiscal years as set forth in the first column. Second, I find as fact that the total MSI nylon sales, both 66 and 46, are as set forth through the years 1983 and 1990, inclusive, and I infer that the estimate of $2,876,572 in sales through 6-19-91 is accurate and I adopt it as a finding of fact. So the total MSI nylon sales that the Court's working with is $17,897,479.

Pursuant to the rulings of law already made, the Court engages in a lost profits analysis, and I think the way to approach this is to address my tentative considerations when I came on the bench this morning.

I had, at the close of Pall's case on damages, said that 25 percent of the total MSI nylon sales market was an accurate calculus, for purposes of damages, of the lost sales that Pall would have made. I had thought, on reflection, that that was overly generous because it presumed, or it, it instantaneously awarded 25 percent of the MSI sales to Pall. And I had thought that an appropriate analysis, consistent, drawing appropriate and fair inferences from the facts, would have been to start with a Pall penetration of the market at approximately five percent per year, five percent

for '83, ten percent in '84, 15 percent in '85, 20 percent in '86, and 25 percent thereafter, stabilizing at 25 percent. The argument of Mr. Phelps convinces me that that's error. The portion of the spreadsheets which I'm treating as briefs, the specific one which speaks of Pall average market share leads me to believe that that is too crabbed a construction of the market share that Pall would have attained. I have in mind specifically that the, when we talk about cartridges, the MSI cartridges did not meet the requirements of the pharmaceutical industry, and it seems likely that, there is a reasonable probability that Pall would have been positioned to garner the bulk of that market. Likewise, I'm struck by the evidence that Cuno was not in the disk market at all, and I have reflected on the argument made.

I think the argument fails to take into account two critical points upon which the Court pens its analysis, and they are these. First, there is a significant price differential between Pall's, the prices of Pall's items and the prices of MSI's items. Some of Pall's items are fifty percent higher in price than the corresponding MSI item. The Court infers that with such a price differential some people will refuse to buy from Pall at all, even if it is the only supplier, and they will not, they will not, they will no longer be part of the market. Further, I infer that others will look for, perhaps, a less workable but acceptable substitute. I think the price differential is significant here. Further, I infer that as one comes to dominate a market more completely, as it appears Pall dominates the cartridge and disk markets for nylon materials, a party who is capable of entering that market, as, of course, Cuno can enter that market, is more inclined to do so if they can undercut Pall's price at all. Because they know that if they can produce and can go forward without fear of patent suit or the like, they can

produce the item then at a lesser price, they know there's a market for that item.

All those things taken into account leads the Court to believe that the lost sales of 25 percent for each year, starting in 1983, is an appropriate and reasonable inference, having in mind the various variables just discussed, and so I adopt and find the second column, that is, the third column in this spreadsheet, Pall's lost profits.

Now, I've said that I'm following a blended approach here so it's necessary to calculate the royalty -- well, before we get to that, before we get to that, and I'm too precipitant in adopting those figures as Pall's lost profits because I have not commented on the strenuous argument that Pall has made with respect to its average profitability, and the evidence that it proffers that its average profitability is 67.2 percent.

Let me be clear. With respect to his calculus, I do not -- first of all, I think the calculus is an appropriate calculus. That's my reference in the rulings of law to Judge Harrington's decision in this district and his citation of Paper Converting Machine Co., the incremental income analysis is appropriate. Second on this point, I do not in any way fault the calculations given the assumptions that he was given of Mr. Petran. It seems to me that's an appropriate way to go about the calculus. I disagree with the assumptions. I am not satisfied, Pall bears the burden of proof on this, and I simply don't believe that, with respect to a significant portion of this market, the transfer membrane market, where Pall would, it seems a reasonable inference to this Court, have to tool up to meet the bulk of what MSI was doing, that its research and development costs would be as small as were testified to, that its direct material costs would not be greater than was testified to, and so I disagree with the assumptions that Mr. Petran was given and believe that the incremental profitability found

by the Court which I now expressly find of 45 percent is appropriate. I think that's justifiable on this evidence. I recognize MSI's arguments to the contrary, but I think that's justifiable and I so find.

Now, with that finding, then I make the findings in column three. Royalty damages, I persist in thinking after the 15 part test of Georgia-Pacific that a royalty of eight percent is an appropriate royalty and I make the findings in column four.

With respect to prejudgment interest, the Court rules, absent some justification for withholding such and award, prejudgment interest should be awarded both on the lost profits and reasonable royalty portions of the damage award. General Motors Corporation v. Devex Corp., 461 U.S. 648, 657 (1983). I award prejudgment interest and make the findings set forth in the fifth column.

With respect to the Nylon 66 willfulness damages, the Court does not treble the damages, the Court doubles the damages. And while, if I put my thought to it I could figure out a mathematical formula to back off these numbers we have here, to get an adequate number, I've not puzzled my mind to do it because I expect that you will do it for me, and I direct that it be done. The damages will be doubled, but I am fully satisfied with the basis for those damages working through the 1990 fiscal year and the 1991 fiscal year to April 2nd, 1991.

Now, that takes through the total damages with but one alteration and that's reducing the amount of the willfulness damages.

Now, with respect to attorneys' fees. I have some matters to say about attorneys' fees. First, I am satisfied under the patent laws that the attorneys' fees portion of an award, properly awarded here, can include the actual costs for testifying expert witnesses and their participation in preparing and testing and testifying with respect to the case.

In this case, I have excluded from the calculus any sum having to do with Mr. Petran simply because it seems to me that his work has done, really, and he, the heavy lifting of his job had been completed before 46 came into the case. No so for Dr. Kesting. I have calculated Dr. Kesting here, or in the calculus that I have reached.

I want it clear that I expressly reject the suggestion in any way that the case has been overstaffed. This Court -- overstaffed by Pall. This Court is quick, perhaps too quick on occasion, to perceive what it believes to be overstaffing of a case looking back to those days, now some 14 years ago, when I was in practice. And perhaps that's wrong. But while there are cases that are overstaffed, this is not one of them. In this case, the Court appreciates the, what is clear the delegation of responsibility, the division in the presentation of the case. And, while I probably don't do justice to the lawyers involved, Mr. Hartmann's concentration on the liability aspects, Mr. Phelps' concentration on the damage aspects, Mr. Field's concentration on matters of local practice, at each turn, since this Court has had the responsibility for this case, Pall has been assiduous in providing the Court with the documentary support for its contentions in a timely, efficient, useful fashion. The premarking of documents, the manner in which they were cataloged, the prompt submission of briefs on matters of the Court's interest, all of those things convince the Court that there's been no overstaffing of this case; rather, there has been a lawyer-like presentation of the evidence, the presentation for me, of course, has been lawyer-like on both sides, but I'm awarding attorneys' fees to Pall here on, for the reasons I pointed out.

In one respect, I will take Mr. Phelps to task only for saying that -- well, you're right. If we were to talk about how many pages of transcript, Mr. Phelps, you're

probably right, one-third for you and two-thirds for them. But the point is the estimates should have included both. So in future cases when you make estimates, include both, as best you can. That said, there's been no overstaffing here.

Now, while there's been no overstaffing, the Court does not simply adopt the attorneys' fees submissions that are made here. My own analysis, and I recognize that it's rough, as the plaintiffs themselves concede that estimates must be made, that taking into account the incremental, if you will, advantages to be gained from the familiarity with the case and the like, the stepping stone that the attorneys had through the careful presentation of the 66 case and the advantages to be gained to the case overall by the efforts devoted to the case in April and May, the Court thinks that, including Dr. Kesting's contribution, and evaluating the quality of the presentation before the Court, the nature of these services in the marketplace generally, the evidence that's presented, the comment made by Mr. Huettner, that attorneys' fees inclusive of $300,000 are appropriate and they are awarded.

Now, I've only made two choices. I could do the subtraction. Mr. Phelps is right there to tell me what the, what doubling the willfulness damages are. And what we'll do is, I will suspend, now, I'm going to recess, you go and prepare a spreadsheet that reflects what I've said, and also prepare a judgment, or give me the, you don't -- yes, do ahead, prepare the judgment that gives me the figures, confer with Mr. Huettner about it, and I will enter it on Monday.

Now, that's, that's so much for the findings of fact and rulings of law on damages.

Let's address this motion here now to reach and apply. If we're going to enter the judgment on Monday, judgment's going to be in the vicinity of $4 million, plus a

little, I imagine. I guess, in effect you want to amend. Well, you say you want to add these people as defendants. This motion is in effect the amendment, this is what you propose to serve on them?

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

91-1393, -1394, -1409

PALL CORPORATION,
Plaintiff/Cross-Appellant,

v. ORDER

MICRON SEPARATIONS, INC.,
Defendant-Appellant.

Before RICH, Circuit Judge, NEWMAN, Circuit Judge, and MAYER, Circuit Judge.

A petition for rehearing having been filed by the APPELLANT,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for rehearing be, and the same hereby is, DENIED.

The mandate of the court will issue on October 31, 1995.

FOR THE COURT,
FRANCIS X. GINDHART,
CLERK

Dated: October 24, 1995

by /s/_____
Diane M. Frye
Chief Deputy Clerk

United States Court of Appeals for the Federal Circuit

OPINION ANNOUNCING
JUDGMENT OF THE COURT

OPINION FILED AND JUDGMENT
ENTERED: September 26, 1995

The attached opinion announcing the judgment of the court in your case was filed today. The judgment was entered pursuant to Rule 36. The mandate will be issued in due course.

Information is also provided about petitions for rehearing and suggestions for rehearing in banc. The questions and answers are those frequently asked and answered by the Clerk's office.

Each side shall bear its own costs.

Exhibits and visual aids shall be promptly retrieved by the party that lodged them with this court.

FRANCIS X. GINDHART
Clerk

CC: STEVEN M. BAUER
H. MICHAEL HARTMANN
R.W. PARKHURST
R.E. HOFER
D.S. CHISUM
S.L. MISROCK
R.C. MOY

PALL CORP. V. MICRON SEPARATIONS, 91-1393
(DCT - 86-1427-Y)

2-229 CIP

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

: F. Spear Group Art Unit:

: David B. Pall

: 198,569

Filed: October 20, 1980

For: PROCESS FOR PREPARING HYDROPHILIC POLYAMIDE MEMBRANE FILTER MEDIA AND PRODUCT

P.O. Box 1
Jericho, New York 11753

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Please amend this application as follows:

In the Specification:

Page 23, line 3, change "sebacamide" to --dodecandiamide--.

REMARKS

An error in identifying Nylon 612 at page 23, line 3 is corrected. Polyhexamethylene sebacamide is Nylon 610 (see page 22, line 24); Nylon 612 is prepared from the twelve carbon dicarboxylic acid dodecanoic dicarboxylic acid, hence, polyhexamethylene dodecandiamide.

This application is a continuation-in-part of Serial No. 905,698 filed May 15, 1978, of which claims 1 to 74 and 96 and 97 were allowed in the Official Action of July 21, 1980, but which now stands abandoned. The allowed claims of that application now appear in this application as claims 1 to 76.

These claims define alcohol-insoluble polyamide resins which form skinless hydrophilic alcohol-insoluble polyamide membranes that are readily wetted by water as selected from the group consisting of polyhexamethylene adipamide, polyhexamethylene sebacamide and poly-e-caprolactam.

The application Serial No. 905,698 has been refiled to provide basis for a narrow subclass of polyamide resins disclosed in Serial No. 905,698 that form such skinless hydrophilic membranes. All members of this subclass have a ratio CH_2:NHCO of methylene CH_2 to amide NHCO groups within the range from about 5:1 to about 7:1, including polyhexamethylene adipamide (Nylon 66), poly-e-caprolactam (Nylon 6), polyhexamethylene sebacamide (Nylon 610), poly-7-aminoheptanoamide (Nylon 7), polyhexamethylene azeleamide (Nylon 69), and mixtures of two or more thereof, as well as mixtures thereof with higher polyamide homologues such as polyhexamethylene dodecandiamide (Nylon 612) in proportions such that the mixture has an average of CH_2:NHCO ratio within the stated range. The first three polyamides, Nylon 66, Nylon 6 and Nylon 610, are preferred.

The other polyamides disclosed in Serial No. 905,698 have been found not to form hydrophilic skinless membranes. Some of them, those that have a ratio CH_2:NHCO of methylene CH_2 to amide NHCO groups within the range from about 7:1 to about 12:1, form skinless liquophilic membranes. The others form hydrophobic skinned membranes.

Accordingly, claims 77 to 162, in parallel to claims 1 to 76, claim this subclass of polyamide resins having a ratio CH_2:NHCO of methylene CH_2 to amide NHCO groups within the range from about 5:1 to about 7:1, and mixtures of two or more thereof, as well as mixtures thereof with higher polyamide homologues in proportions such that the mixture has an average of CH_2:NHCO ratio within the stated range.

In addition, Examples 65 to 68 are added, illustrating these polyamide resins.

All of claims 77 to 162 are deemed allowable over the art cited against Serial No. 905,698, for the same reasons as claims 1 to 76.

These claims are also supported by the showing of record in Serial No. 905,698 in the Declaration under Rule 132 of Dr. Pall, the inventor herein, and the demonstration made at the recent interview before the Examiner, also of record.

As indicated at the interview, the claims of Serial No. 905,698, although not rejected on the grounds of undue breadth, were amended because, on the basis of research done since this application was filed, the applicant now considers that the process described and claimed herein is actually applicable only to polyamide resins which are polymers of aliphatic diamines and aliphatic saturated dicarboxylic acids having from six to ten carbon atoms. This in fact is the same class defined in slightly different terms as the ratio CH_2:NHCO of methylene CH_2 to amide

NHCO groups within the range from about 5:1 to about 7:1.

A six carbon acid with a six carbon diamine (Nylon 66) or a six carbon amino acid (Nylon 6) give a polyamide having a ratio of 5:1; a nine carbon acid with a six carbon diamine (Nylon 69) gives a polyamide having a ratio of 6.5:1; and a ten carbon acid with a six carbon diamine (Nylon 610) or a nine carbon amino acid give a polyamide having a ratio of 7:1. In the acid or amino acid the number of CH_2 groups is two less than the number of carbon atoms, because two carbon atoms are in the $CONH_2$ groups as CO.

The preferred polyamide resins of the subclass now recited in the claims are still polyhexamethylene adipamide (Nylon 66), poly-e-caprolactam (Nylon 6), and polyhexamethylene sebacamide (Nylon 610). To these, poly-7-aminoheptanoamide (Nylon 7), polyhexamethylene azeleamide (Nylon 69), and mixtures of two or more thereof, as well as mixtures thereof with higher polyamide homologues such as polyhexamethylene dodecanamide (Nylon 612) in proportions such that the mixture has an average of CH_2:NHCO ratio within the stated range, are now added. The limits of the class are thus aliphatic dicarboxylic acids having from six (adipic) to ten (sebacic) carbon atoms, if the diamine has six carbon atoms. In this connection, note the additional discussion of polyamide resins at page 26, line 16 to page 27, line 18.

The references cited against Series No. 905,698 were as follows:

Marinaccio et al No. 3,876,738
Brown et al No. 3,894,166
Jamison No. 3, 389,206
Pall et al No. 3,457,339
Sharp No. 3,524,753
Lovell et al No. 2,783,894

The Declaration of Dr. Pall responded to the rejections of the claims which are set out in the Official Action of December 3, 1979, in Serial No. 905,698, beginning at page 2.

Claims 1, 2, 5 to 31, 96 and 97 were rejected as unpatentable over Marinaccio et al in view of Brown et al under 35 USC 103. The Brown et al reference was relied upon for its disclosure of a support, and the Examiner asserted that it would be obvious to use the support of Brown et al in the Marinaccio et al process. This of course assumed that the Marinaccio et al process is so similar to the applicant's that it will give the same product as the applicant's process, but that this is not so is demonstrated by Dr. Pall in his Declaration.

The Examiner asserted that there is some nucleation in the Marinaccio et al process, and that the applicant's specification at pages 43 to 44 suggested that there is some nucleation in Marinaccio et al. This point is also answered by Dr. Pall in his Declaration.

The invention provides a process for preparing skinless hydrophilic alcohol-insoluble polyamide membranes that are readily wetted by water, which comprises:

(1) preparing a solution of an alcohol-insoluble polyamide resin that is either selected from the group consisting of polyhexamethylene adipamide, polyhexamethylene sebacate, and poly-e-caprolactam (claims 1 to 76) or has a ratio CH_2:NHCO of methylene CH_2 to amide NHCO groups within the range from about 5:1 to about 7:1 (claims 77 to 162) in a polyamide resin solvent;

(2) inducing nucleation of the solution by controlled addition to the solution of a nonsolvent for the polyamide resin, under controlled conditions of

concentration, temperature, addition rate, and degree agitation to obtain a visible precipitate of polyamide resin particles, thereby forming a casting solution;

(3) spreading the casting solution on a substrate to form a thin film thereof on the substrate;

(4) contacting and diluting the film of casting solution with a nonsolvent liquid for the polyamide resin, thereby precipitating polyamide resin from the casting solution in the form of a thin skinless membrane;

(5) washing the membrane to remove solvent; and

(6) drying the resulting membrane.

Dr Pall pointed out that this process is being used commercially by Pall Corporation, and that skinless hydrophilic alcohol-insoluble Nylon 66 membranes obtained in the process are being offered to industry. Attached to the Declaration is a copy of brochure NM 900, issued February, 1980, The Pall Ultipor N_{66} Membrane Filter Guide, which describes the commercial product. Note in particular the unusual characteristics of these membranes that are pin-pointed on page 5.

The inventive step of this process that is not shown or suggested in any of the cited references is step (2), inducing nucleation of the selected class of polyamide resins in solution in a polyamide solvent by addition to the solution of a nonsolvent for the polyamide resin under controlled conditions of

(i) concentration,
(ii) temperature,
(iii) addition rate, and
(iv) degree of agitation,

to obtain a visible precipitate of polyamide resin particles, thereby forming a casting solution.

In addition, in forming the membrane there have to be controlled the other parameters described in the

specification, particularly the concentration of the bath in which the membrane is formed.

The alcohol-insoluble polyamide resin membrane sheet that is provided in accordance with the invention is inherently hydrophilic. This is a most remarkable property, inasmuch as the alcohol-insoluble polyamide resin from which the sheet is made is hydrophobic. The reason why the polyamide resin membrane sheet prepared in accordance with the process of the invention is hydrophilic is still not established by conclusive proof, but in Dr. Pall's opinion, based on the available evidence, it is due to a spatial orientation of the hydrophilic groups of the polymer chain that is fixed in the solid polymer membrane surface as a result of the precipitation process. It may be related to crystal structure or to solid structure, or to some spatial form of the NH and/or CO groups on the surface of the membrane sheet, facilitating its being wetted by water.

As demonstrated at the interview, the hydrophilicity of the applicant's polyamide membranes is apparent from the fact that a drop of water placed on a dry polyamide resin membrane sheet of the invention will penetrate into the sheet and disappear within a few seconds. A sheet of dry membrane placed on the surface of a body of water will be wetted through and may even sink in the water within a few seconds. If the membrane is completely immersed in water, the membrane is wetted through in less than a second.

The capability of the membrane's or substrate's being wetted by water is determined by placing a drop of water on the membrane or substrate surface. The angle of contact provides a quantitative measure of wetting. A very high angle of contact indicates poor wetting, while a zero angle of contact defines complete or perfect wetting. The polyamide resin starting materials from which the membranes of this invention are made have a high angle of

contact, and are not wetted by water. This was demonstrated at the interview, using a slab of Nylon 66 resin as supplied by the manufacturer, du Pont.

The wettability of the applicant's membranes is not a function of retained water. Membrane specimens dried at 350° F for 72 hours in an inert atmosphere, in vacuum, and in air, are unchanged with respect to wettability by water.

The hydrophilicity can however be lost if the hydrophilic membrane is heated to a temperature just below the softening temperature of the membrane (to heat at a higher temperature would of course destroy the membrane, since it would melt). At such temperatures, the membrane reverts to a hydrophobic material, which is no longer wetted by water. This also was demonstrated to the Examiner at the interview.

This suggests that the hydrophilicity is a function of solid structure, and is obtained by the process of membrane formation, probably during precipitation of the membrane in the course of the process. It may be associated with crystal structure, or it may only be associated with noncrystalline or amorphous solid structure, but it does appear to be related to a physical orientation of the hydrophilic groups in the polyamide chain, which orientation is lost when the membrane film is heated to a high enough temperature to permit reorientation to a normal configuration, in which the material is hydrophobic.

Dr. Pall referred to the Examiner's comment in the Official Action of December 3, 1979, regarding the hydrophilicity of the membranes of the instant invention, vis a vis the membranes obtained by Sharp, and the Examiner's comment that some nucleation is inherent under some conditions, in the process described by Marinaccio et al. Dr. Pall stated that these assertions are however demonstrably incorrect, for the following reasons.

The formation of a hydrophilic polyamide resin membrane from a polyamide resin that is inherently hydrophobic is a quite remarkable phenomenon. The fact that it happens at all is truly quite amazing. A hydrophobic polyamide resin would be expected to remain hydrophobic when processed to accept a membrane or film form under conditions that impose only physical and no chemical change on the polymer, as in the present process, as well as in the process of the prior art, because this is the nature of the polymer. A chemically unmodified membrane of the polymer can hardly be expected to display a different hydrophobicity from the polymer itself, since it is composed substantially entirely of that polymer.

Nonetheless, under the peculiar circumstances of the physical change imposed upon the polymer in the course of the process in accordance with the invention, the membrane that is obtained is hydrophilic, not hydrophobic. Moreover, its hydrophilicity is unstable. If the membrane be heated to a temperature that is sufficiently high to disturb the solid structure of the membrane, the membrane reverts to hydrophobic, and behaves in the same hydrophobic manner as does the original polymer.

The phenomenon of hydrophilicity arises primarily as a result of nucleation of the casting resin solution. Nucleation is complex, and at present very imperfectly understood.

As explained in the specification of this application, beginning at page 29, the state of nucleation of the casting resin solution is strongly affected by six major physical working conditions:

(1) Concentration, temperature and molecular weight of the starting resin solution;

(2) Composition and temperature of the nonsolvent, or of the nonsolvent-solvent mixture.

(3) The rate at which the nonsolvent, or nonsolvent-solvent mixture, is added.

(4) The intensity of mixing during the addition.

(5) The geometry of the apparatus in which the mixing is accomplished.

(6) The temperature of the resulting casting resin solution.

The terms "nucleation" and "state of nucleation" refer to the apparent explanation of the following observations:

> (a) casting resin solutions can be prepared with a wide variation of composition with respect to resin, solvent, and nonsolvent concentrations, which yield identical or nearly identical membranes; and
>
> (b) casting resin solutions can be prepared, which have equal resin, solvent and nonsolvent concentrations, which are then cast at equal temperatures into the same bath, yet yield very different membranes; in fact, the resulting membranes can run the gamut from "not useful" in the sense of having very significantly lower flow-by factors of 2 to 5 or more-compared with Table 1 of the specification.

Since the preparation of casting resin solutions capable of producing membranes with flow properties in the useful range has been observed to invariably be accompanied by the local precipitation and at least partial redissolution of solid resin, and since it is well known to those familiar with the chemical arts that the characteristics of a solid precipitated from solution can be greatly influenced by the presence or absence of submicroscopic nuclei, Dr. Pall has chosen to use the term "state of nucleation" to distinguish casting solutions having equal

composition, but diverse results, as described in paragraph (b) above, and to account as well for the observation of paragraph (a).

The assumption that nucleation accounts for the differences in behavior of membranes made from casting resin solutions of equal composition is confirmed by the results of an experiment in which a stable casting resin solution was prepared, with a degree of nucleation controlled to yield a 0.4 μM absolute membrane. A portion of the casting resin solution was subjected to fine filtration to determine whether nucleation behavior would be affected, and the properties of membranes cast from the two lots of casting resin solution were compared.

Examples 58 and 59 of the specification show the results of this experiment; product characteristics are greatly altered by fine filtration; the finely filtered casting resin solution produces a membrane with a very poor ratio or flow capacity to removal rating; the Δp of Sample No. 59 is more than three times higher than that for a similar membrane made using a properly nucleated casting resin solution of this invention.

Dr. Pall considers that this result supports the theory that resin nuclei are developed during the controlled-condition dilution used to prepare the casting resin solution, whose number, size, or other characteristics strongly influence the characteristics of the membrane generated by that casting resin solution, and that at least a portion of these nuclei were removed by fine filtration.

After the cast film of liquid enters the bath, a precipitation process occurs, whose mechanism is not completely understood. The nonsolvent mixture of the bath diffuses into the cast film, and the solvent mixture in the casting resin solution diffuses out of the film into the bath, but it is not understood why this results in a uniform pore

size throughout the thickness of the film when the bath solvent-nonsolvent ratio is held within certain limits.

If the bath contains only nonsolvent (such as water, alcohols or organic esters), or nonsolvent with a small proportion of solvent (e.g., water with less than 15 to 20% of formic acid) precipitation occurs very rapidly, and the solid membrane is formed within a few seconds, typically in less than 1 to 10 seconds. Membranes made in this manner are heavily skinned, regardless of the mode of preparation of the casting resin solution, and are undesirable.

If the bath contains about 43 to 47% of formic acid in aqueous solution, and the casting resin solution is properly nucleated as described herein, the resulting membrane will be uniform in pore structure from face to face, provided only that it case on a solid substrate, the surface of that substrate be wetted by the casting resin solution and by the bath solution. The time required for the film to form under these circumstances is a function of the following:

(a) Casting resin solutions which produce membranes which have high K_L values (e.g., in excess of 100 psi) set very rapidly, e.g., in less than 10 seconds. Less highly nucleated casting resin solutions, producing membranes with K_L values of about 40 to 50 psi will typically set in the 10 to 20 second range, and the setting time continues to increase as K_L decreases, such that membranes about 0.006 inch thick with K_L values of under 20 psi require about 5 minutes or more to set, and still lower K_L's require still longer periods.

(b) Thickness of the cast film is an important parameter, setting times being shorter for thin films.

(c) Use of lower casting resin solution temperatures results in faster setting.

(d) Setting is faster at the low end of the 43 to 47T recommended range, and can be further speeded by use of bath concentrations of less than 43% formic acid, at the cost of only slight deviation from pore uniformity.

As the bath concentration decreases to and below the 40 to 43% range, the membranes become progressively more asymmetric, progressing from uniform as shown in Figures 5 and 6 of the specification, to tapered pore as shown in Figure 7 of the specification, to skinned as shown in Figure 8 of the specification, to heavily skinned as shown in Figure 9 of the specification. Operation at formic acid concentrations much lower than those producing tapered pores as exemplified by Figure 7 is undesirable.

The formation of the membrane from a casting resin solution can be carried out as an intermittent or batch operation or as a continuous or semicontinuous process. A small scale operation may be most conveniently carried out as a bath operation, while at high production rates a continuous or semicontinuous operation is more convenient. In all types of processes, it is important to carefully control all of the operating parameters to ensure a uniform product, including operating temperatures, and relative proportions of resin solution and nonsolvent liquid. The control of conditions of nonsolvent addition are particularly important, including the geometry of the apparatus, the rates of flow, and duration and intensity of mixing; also the interval between nonsolvent addition and casting of the resin film must be controlled. Such controls can be established by trial and error experimentation without undue difficulty by those skilled in this art, taking into account the following considerations:

It is important that the casting resin solution be clear, and free from suspended material, before being spread upon the substrate to form a film. If suspended material is present, such as undissolved resin particles, these are removed by screening or filtration before casting.

The Examiner asserted that some nucleation must occur in the Marinaccio et al process, observing that during the addition of small amounts of nonsolvent, there would come a time when a small amount of precipitate would form temporarily, and immediately dissolve. This is however quite a remote possibility, and taking into account what Marinaccio et al teach one skilled in the art to do, requires that one depart from Marinaccio et al's instructions, and do exactly what they say not to do.

Marinaccio et al describe a process for producing microporous membrane sheets from alcohol-soluble and alcohol-insoluble polyamides such as Nylon 6, poly-e-caprolactam, and Nylon 610, polyhexamethylene sebacamide, by casting a solution of the polymer on a substrate and then precipitating the membrane, both steps being carried out sequentially or concurrently in a quenching bath of nonsolvent liquid.

The nylon solution after formation is diluted with a nonsolvent for nylon, and the nonsolvent employed is miscible with the nylon solution. Marinaccio et al discuss polymer molecule aggregation in solution, and assert that "the tightest or most nonporous polymer film is produced from a solution in which there is no aggregate formation". Dr. Pall notes, however, that what Marinaccio et al refer to as "aggregation" is not the phenomenon to which he refers as nucleation.

Aggregation of molecules in solution is a concept used by polymer chemists to explain the decrease in viscosity of a polymer solution when solutions of equal concentration are prepared in a good solvent and in a poor

solvent. The molecules in a good solvent are pictured as being relatively "stretched out" to linear or near linear form, resulting in entanglements which account for the higher viscosity compared with the same molecule in a poor solvent, where it is pictured as "balled up", thereby resulting in lower viscosity. The "aggregated" molecules in a poor solvent are not nuclei, and are not removed by filtration. In the discussion by Marinaccio, the good solvent is formic acid, while the poor solvent is formic acid with water added, which solutions of polyamide resins do indeed have lower viscosity.

According to Marinaccio et al, ". . . the resulting film strength is primarily determined by the polymer concentration because of the larger number of chain entanglements occurring at higher polymer levels. In addition, for film cast from the ideal solution the "poor size" would increase slightly with polymer concentration because of the increasing aggregation tendency at higher concentrations. Aggregation in solution results in film porosity since the film as cast can be thought to consist of interacting aggregated spherical particles. The larger the spheres, the larger the voids in the film. Structurally this is much like a box of tennis balls or other nonspherical geometrics fused at their point of contact."

As a first step, then, Marinaccio et al control film porosity by "control of the aggregation tendency in the casting solution. This is accomplished . . .by the addition of nonsolvent or other additives to change the solvent power of the solution, hence influencing and controlling the aggregation tendency of the polymer molecules. The interaction of these aggregates in determining the resulting film structure is further influenced by the various process variables previously maintained."

This is Marinaccio et al's theory, but Dr. Pall believes that it is not adequate to explain what actually

occurs, and is in many respects not consistent with actual observations. Moreover, it differs from other more generally accepted theories advanced to explain polymer membrane formation, as for instance, Synthetic Polymeric Membranes, Kesting (McGraw Hill 1971) pp 117 to 157. Kesting's theory is more credible for a number of reasons; for example, it accounts for the very high voids volume of the membranes, which Marinaccio et al's "tennis ball" theory fails to do; further it explains why only relatively polar polymers are susceptible to membrane formation, which again Marinaccio et al do not.

Marinaccio et al then assert: "The selection of a solvent for a selected film-forming polymer can be made on the basis of the foregoing information. Determination of optimum solvent systems as well as other process variables can then be made on the basis of routine laboratory experimentation." However, dilution of the solution by addition of a nonsolvent has a limit: "dilution with nonsolvent can be effected up to the point of incipient precipitation of the nylon, but not beyond." The casting solutions are stable enough to be subjected to aging periods of as much as five to eight days, and indefinitely in some cases, but not so long that the dissolved nylon separates.

It is apparent from the above quotation that at no time during the addition of small amounts of nonsolvent in the Marinaccio et al process could there come a time when a small amount of precipitate would form temporarily and immediately be dissolved, as the Examiner asserts. Marinaccio et al expressly exclude this possibility by requiring that dilution with nonsolvent be effected "up to the point of incipient precipitation of the nylon, but not beyond". Thus, one does not proceed to a point when a small amount of precipitate would form. If this were to occur, Marinaccio et al state, one must discard the solution, because one must not go as far as this point.

In any event, the formation of a precipitate is not indicative of nucleation. A precipitate can form, exist only temporarily, and immediately be dissolved, and still the solution need not be nucleated. While the formation of a precipitate may be necessary, it is not sufficient.

The formation of a nucleated solution, as Dr. Pall has noted, requires control of the following factors:

(1) Concentration, temperature and molecular weight of the starting resin solution;

(2) Composition and temperature of the nonsolvent, or of the nonsolvent-solvent mixture.

(3) The rate at which the nonsolvent or nonsolvent-solvent mixture is added.

(4) The intensity of mixing during the addition.

(5) The geometry of the apparatus in which the mixing is accomplished.

(6) The temperature of the resulting casting resin solution.

The Examiner further asserted that the applicant's specification at pages 43 to 44 suggests that there is some nucleation in Marinaccio et al. Upon review of those pages, it appears that the Examiner's reading of them must be in error. What is said about Marinaccio et al appears at page 44, staring at line 1:

"Membranes made on the assumption that the concentrations of the components are the controlling factors, and without nucleation, for example, by the process of Marinaccio, fall into this range, and tend to be of relatively poor quality." In Region B, the pore size decreases in a regular, though not necessarily linear fashion, as the degree of nucleation increases. In Region C, the casting resin solution becomes increasingly populated by particles of resin which have not redissolved, but still produces good quality membrane. If these are removed by filtration prior to casting; and in Region D, the resin

solution from which these lumps have been removed by filtration becomes unstable, and prone to early local or overall gelation before the film can be cast. The very high degree of nucleation in Region D is sometimes manifested by an opalescent appearance, suggesting that the nucleation procedure has resulted in an excessive number and/or excessively large nuclei."

Accordingly, far from stating that there may be nucleation in Marinaccio et al, it is expressly stated that the process of Marinaccio et al is an example of a process that proceeds "without nucleation", and moreover, that gives a membrane of "relatively poor quality".

Dr. Pall noted that the product of Marinaccio et al has not been commercialized, and is unavailable. In a discussion with Marinaccio et al's supervisor, who knew what actually had been done by Marinaccio et al, Dr. Pall has learned that Marinaccio et al never formed a polymer film by direct immersion of the casting resin into a quench bath. This could be difficult, and it has not been economically feasible to attempt to do so, particularly since Marinaccio et al did not. None of Marinaccio et al's Examples include formation of the film in a quench bath in this way, but instead are manually cast in individual laboratory tests onto glass plates.

Neither is the Sharp et al product available commercially. However, Sharp says enough about it that it is obvious it is hydrophobic.

Example 6 shows the formation of a microporous film from Nylon 66 polymer. Since the polymer is hydrophobic, it would be expected, from the process described, that the film would also be hydrophobic.

While Sharp does not use the terms "hydrophobic" or "hydrophilic" regarding the Nylon 66 membrane of Example 6, at column 6, lines 55 to 66, Sharp states:

> The microporous films described in the above examples all exhibits a Suter hydrostatic pressure of from 15 to 60 ins. H_2O, and at atmospheric pressure provided a very efficient barrier to the penetration of water and most aqueous solutions.
>
> Such films or diaphragms are particularly suitable for use as very fine filters for the removal of particulate matter from gases and liquids, in the case of the latter, the liquids being supplied under pressure or the diaphragm being treated with a suitable wetting agent, as described above, as necessary in order to overcome the resistance to liquid penetration.

A material that exhibits a Suter hydrostatic pressure of from 15 to 80 inches of water is hydrophobic. A material that provides a barrier to the penetration of water and most aqueous solutions at atmospheric pressure is necessarily hydrophobic. By definition, a material that is hydrophilic readily absorbs and transmits water, and most aqueous solutions.

If it is necessary to treat the film with a suitable wetting agent, in order to overcome the resistance to penetration by water and aqueous solutions, this means that the film is hydrophobic, because it resists penetration by the liquid.

A material that is hydrophilic is willing to accept an aqueous solution without being treated first with suitable wetting agents. It is a hydrophobic material that has to be treated with a wetting agent, in order to overcome the resistance to liquid penetration.

At column 3, lines 35 to 39, Sharp states as follows:

> One application of the invention is to the manufacture of waterproof or water repellent, vut vapour permeable, material for use in the manufacture of weatherproof garments. In this form of the invention the permanent support may be a woven textile material.

Clearly, a water-repellent or waterproof material is a material that resists penetration by water. Such a material is hydrophobic, and this conforms with the properties of the diaphragms described in the working Examples, including, specifically Example 6.

The Examiner asserted that the membrane of Sharp is hydrophilic, compared to nonporous polyethylene. Nonporous polyethylene is hydrophobic. However, Dr. Pall states categorically that it is impossible to conclude that the Sharp Nylon 66 film is hydrophilic, even when compared to nonporous polyethylene, as the Examiner asserts. From what is said regarding resistance to penetration by water, Dr. Pall believes that it is clear that the film is hydrophobic, not hydrophilic.

The Examiner further asserted that one would obviously expect a very thin, very porous film to be completely wettable throughout, as claimed, even if hydrophobic. However, whether or not the film is thin or porous, it will not be wettable through by water, if it is hydrophobic. Only if it is hydrophilic, like the polyamide resin membrane of the invention, will it be wetted throughout. If the membrane, although very thin and very porous, is hydrophobic, it will not be completely wettable throughout.

Dr. Pall has demonstrated this by taking the hydrophilic membrane of the invention, which

demonstrably can be wetted by water throughout, and showing that this property is completely lost, and the membrane becomes hydrophobic, resistant to the penetration of the water, after the membrane has been converted by heating to the hydrophobic form. The membrane when converted to this hydrophobic form, even though otherwise identical to the hydropholic form, behaves as a water-repellent membrane, resistant to penetration by water, exactly as described by Sharp for his Nylon 66 membrane, and this despite the fact that it is very thin and very porous.

Dr. Pall has shown this in the following Experiments:

EXPERIMENT 1

Nylon 66 resin pellets of molecular weight approximately 42,000 were dissolved in 98.5% formic acid at 35 C to yield a solution containing 15.5% of the resin. Without delay, this solution was delivered at a flow rate of 250 g/minute to an in-line mixer. Simultaneously, a controlled water flow at 31°C was delivered to the mixer, the quantity being such as to produce as the effluent a casting resin solution containing 70.2% of formic acid and 13/5% of the resin. The casting resin solution was filtered through a 10 μM filter to remove visible resin particles, and was then formed as a thin film by a doctoring roll with 0.0085 inch spacing on a moving polyester sheet surface, which had been pretreated by corona discharge to improve its wettability; and in less than 3 seconds immersed into a bath containing at 46.5% formic acid, balance water, for approximately 3 minutes. Bath concentration was maintained constant by adding water continuously, in the amount required. The nylon membrane so formed was

washed with flowing water for 1 hour. Two layers of the membrane were removed from the polyester substrate sheet and oven dried in contact with each other, while restrained to prevent shrinkage of the length and width during drying.

The rotation rate of the in-line mixer was varied from 400 to 1600 RPM during this run. Table I shows the product characteristics obtained. In this Table, "uniform pores" means that the pore size was equal, as determined by SEM examination throughout the whole width of the membrane.

TABLE I

Sample No.	Mixer RPM	Casting resin temp. °C	K L PSI	?p[1]	t mils	Estimated T R (Ps.)	Absolute particle rating, ?M	Remarks
1	800	53	31.4	4.0	5.8	1.4×10^{9}	0.47	Uniform pores
2	600	51	39.3	5.6	6.5	1.1×10^{17}	0.20	Uniform pores

[1] Pressure drop in inches of mercury column at air flow rate of 28 feet/minute.

The fact that each of these membranes was hydrophilic and readily wetted by water was visually observed by placing a drop of water on the untreated membrane. The drop spread rapidly on the surface and was completely absorbed in a few seconds.

Because the drop wetted the membrane surface, it had a zero contact angle, i.e., a contact angle of 0°.

A piece of the membrane was dipped endwise into a breaker of water, whereupon the dipped portion wetted through, and when the entire piece was immersed it sank immediately.

The hydrophilicity was also quantitatively verified by plotting capillary displacement pressure vs. surface

tension of the wetting liquid. The resulting plot is linear, from 22 to 74 dynes/cm, when the wetting liquid is water.

Displacement pressure of a single capillary is readily observed visually. Measurement of the displacement pressure of a multipored membrane is complicated by the diffusional flow of air through the liquid layer formed when the membrane is wetted. Since diffusion flow is proportional to applied pressure, the air flow actually obtained on gradually increasing the pressure to an intact membrane initially shows a constant flow per unit of applied pressure changing abruptly as liquid is expelled from the larger pores to a very rapid rise. A typical curve is shown in the attached Figure 1, which also appears at page 13 of the attached brochure. The intercept of the two lines has been designated as K_L which can be defined as the pressure required to displace the test liquid from the largest ores of the membrane. This is effectively the capillary displacement pressure referred to as K_L. Seepage 13 of the brochure for a further discussion of this point.

In Figure 1, the membrane is wetted by water, which forms an unbroken film within the pores of the filter medium. Since air is soluble in water and, in accordance with Henry's law, solubility increases as pressure increases, more air dissolves in the upstream face of the water film than at the downstream face, resulting in a slow diffusion of air through the water from the upstream face to the downstream face. This diffusion rate is seen in the horizontal portion of the curve of Figure 1 to be about 0.05 cc/min/sq. ft./psi, and is constant up to about 88 psi. Between 88 and 92 psi water begins to be expelled from the larger pores, in the same manner as it is expelled from a single capillary when the pressure is sufficient.

The controlling equation relating this pressure to pore size is the standard capillary displacement equation:

$$K_L = \frac{C\gamma}{D} \cos\theta$$

where K_L = pressure, C is constant, γ is the surface tension of the liquid, D is the pore (or capillary) diameter, and θ is the angle of contact. If $\theta = 0°$, then $\cos\theta = 1$, and the solid is by definition wetted by the liquid.

The surface tension of water, as used to develop the Figure 1 data, is 74 dynes/cm. Other fluids, with surface tensions as low as 15 dynes/cm, can be used to determine K_L; if the fluid has a lower surface tension, the measured K_L will, in accordance with the equation, also be lower. When K_L was determined on the same membrane using a range of liquids with surface tension from 15 to 74, and the K_L is plotted against surface tension, a straight line passing through the origin was obtained; that is

$$\frac{K_L}{\gamma} = \text{constant}$$

For this to be the case, $\cos\theta$, and hence θ, must be constant, and therefore θ is the same for all the liquids. Since a liquid of surface tension = 15 dynes/cm will even wet Teflon (θ = zero), it may be concluded that the membranes made by this invention have zero contact angle with water, and are hydrophilic by the most rigid definition of hydrophilicity.

EXPERIMENT II

Samples of each of the above membranes were heated at 500 °C for 20 minutes, so as to convert the membranes into the hydrophobic form.

A drop of water placed on the dry polyamide resin membrane sheet did not penetrate into the sheet, but instead retained a spherical droplet form. The observed contact angle was about 90°, showing zero wetting.

A sheet of the dry membrane placed on the surface of a body of water floated and remained floating after standing overnight. At the end of this time, the membrane was still not wetted. It did not absorb any water, and did not sink, even when held beneath the surface of the water for 5 minutes.

Measurement of the water-wet displacement pressure of the membrane could not be made, because the membrane is hydrophobic, and therefore could not be wetted by water, to permit running the test.

If thus is apparent that this membrane, even though demonstrably very thin and very porous, since it was in fact a piece of the film previously displaying hydrophilic properties, was not wettable throughout at all.

EXPERIMENT III

A sample of the above nylon membranes was immersed in a 10% solution of Dow Corning SYL-OFF 1107 liquid hydrophobic silicone resin in isopropyl alcohol containing 1% of Dow Corning catalyst XY 170, removed and allowed to air dry to evaporate the alcohol, and was then cured to set the resin by heating in accordance with the manufacturer's directions. the product was a silicone treated membrane, which would be expected to be hydrophobic because the silicone resin was hydrophobic.

The fact that this membrane was hydrophobic and not wetted by water was visually observed by placing a drop of water on the membrane surface. The drop remained on the surface, retaining its spherical form, and

showed a contact angle of about 135°, indicating the surface was hydrophobic.

A sheet of the dry membrane placed on the surface of a body of water floated, and remained floating after standing overnight. At the end of this time, the membrane was still not wetted. It id not absorb any water, and did not sink, even when held beneath the surface of the water for five minutes.

Measurement of the water-wet displacement pressure of the membrane could not be made, because the membrane is hydrophobic, and therefore could not be wetted by water, to permit running the test.

EXPERIMENT IV

Nylon 11 resin pellets were dissolved in hot nylon solvent to yield a resign solution. Without delay, a controlled flow of diluent was delivered to the mixing vessel and combined with the resin solution to produce a casting resin solution. the casting resin solution was filtered to remove visible resin particles and was the formed as a thin film on a nonporous substrate. this film was allowed to cool, whereupon the polymer precipitated, as evidenced by the development of opacity in the film. following the cooling period, the film was immersed into a nonsolvent bath, the concentration of whose components was maintained constant. The nylon membrane so formed was washed and oven-dried while retrained to prevent shrinkage of length and width during drying.

The fact that this membrane was hydrophobic and not wetted by water was visually observed by placing a drop of water on the untreated membrane. The drop remained on the surface, retaining its hemispherical form, and showed a contact angle of about 80 to 105°.

It is thus apparent that this membrane, even though demonstrably very thin and very porous, was not wettable by water.

This shows that Nylon 11 does not behave like Nylon 66, when cast in membrane form by a process similar to that of the present invention, retaining its hydrophobicity, and displaying no hydrophilic property whatsoever.

According, it is submitted, in view of the foregoing, supported by the showing and discussion in the Pall Declaration, that the claims should be regarded as patentable over the combination of Marinaccio et al in view of Brown et al under 35 USC 103. Clearly, there is no nucleation inherent in the Marinaccio et al process, and since Brown et al do not suggest anything of the applicant's process, it does not remedy this deficiency in the Marinaccio et al disclosure. Thus, the combined references do not suggest the applicant's invention; they certainly do not suggest that by the use of the applicant's process it would be possible to obtain a skinless hydrophilic polyamide membrane from the defined class of alcohol-insoluble polyamide resins, a membrane that is readily wetted by water, all properties in complete contrast to the properties of the staring alcohol-insoluble polyamide, which is hydrophobic. It is most remarkable that by application of the applicant's process it is possible to obtain a hydrophilic membrane from a hydrophobic polymer, even so narrow a class of hydrophobic polymers.

As noted by Dr. Pall above, Marinaccio et al at column 6, starting at line 4, discloses dilution of the nylon solution with a nonsolvent:

> The nylon solutions after formation may be diluted with non-solvent for nylon and the non-solvent employed is miscible with the

> nylon solution. Of course, dilution with non-solvent can be effected up to the point of incipient precipitation of the nylon but not beyond. The non-solvents are selected on the basis of the nylon solvent utilized. For example, when water-miscible nylon solvents are employed, water can be employed. Generally, the non-solvent can be methyl formate, aqueous lower alcohols, such as methanol and ethanol, polyols such as glycerol, glycols, polyglycols, and ethers and esters thereof, water, and mixtures of such compounds. Moreover, salts can also be used to control solution properties.

(emphasis supplied)

Clearly, one skilled in the art is told not to add nonsolvent beyond the point of incipient precipitation of the polyamide resin. "Incipient" means that one stops short of the point where a visible precipitate of the polyamide resin forms. This however is precisely what is required in the applicant's claims.

Although Marinaccio et al discloses aging of the nylon solution after formation, at column 6, beginning at line 18 one is told not to age overlong, because the dissolved nylon may precipitate:

> After formation, the nylon solution in the selected solvent, preferably comprised of solvent and non-solvent, is sometimes aged before casting. Aging periods can be varied to obtain a variation in the properties of the resulting microporous film but usually are not for excessive periods since the dissolved

> nylon may tend to separate. In general, aging, when employed, can be extended for as many as 5-8 days and indefinitely in some cases with the preferred nylon solutions.

(emphasis supplied)

Again, the stage beyond incipient precipitation must not be reached.

Thus, Marinaccio et al does not disclose the applicant's nucleation step. On the contrary, it is suggested that the formation of a visible precipitate is undesirable, and is to be avoided.

There are of course other differences between the applicant's process and Marinaccio et al's, which may explain why the applicant finds desirable a feature which Marinaccio et al definitely tend to avoid. However, it certainly cannot be said that this feature of the applicant's claims is obvious in the sense of 35 U.S.C. 103 from Marinaccio et al, because in fact the applicant is doing exactly what Marinaccio et al teach one skilled in the art not to do.

Brown et al adds nothing to the Marinaccio et al disclosure with respect to the preparation of polyamide resin membranes, because it is not concerned with this type of membrane at all. Neither is it concerned with a membrane that is sufficiently porous that it could serve as a filter. Brown is concerned with the manufacture of asymmetric cellulosic membranes having the ability to preferentially exclude dissolved salts when used in so-called reverse osmosis processes. Osmosis is a process for separation of materials by diffusion through a membrane. If the membrane is to exclude from passage therethrough dissolved salts, when an aqueous solution of such dissolved salts is forced under pressure against the membrane (as

described by Brown et al), then the membrane cannot have even micropores, because such pores would pass the aqueous solution intact, without screening out dissolved salts. The Porosity of the membrane must be of so low an order that the flow is flow by diffusion, if the particles of the size of the dissolved salt anions or cations are screened out. This means that the membrane is hardly useful as a filter. The Brown et al membrane certainly does not correspond in porosity to the applicant's, in addition to being of an entirely different material, a cellulosic material, rather than a polyamide.

In addition, the Brown et al membrane has a skin. A skin is required for the purpose of osmosis, as explained in Brown et al at column 1, beginning at line 35. It is the skin that is selectively effective for preventing the passage of the unwarranted dissolved salts to the membrane. The applicant, on the other hand, is concerned with the preparation of a skinless membrane, as the claims in question show.

The process that is used by Brown et al is also entirely different from the applicant's. The process for preparing asymmetric cellulosic reverse osmosis membranes, as set forth by Brown at the bottom of column 1, and the top of column 2, is as follows:

1. casting a viscous "dope" in the form of a thin film upon an appropriate casting web (the dope or solution generally containing one or more suitable film-forming polymeric materials plus one or more special art-recognized "port-producing" materials);
2. exposing the newly cast film of the dope to air or other suitable gaseous

atmosphere for a period of at least about 15 seconds (to thereby somehow cause an incipient change in the exposed surface so that ultimately a microscopically thin active layer can be formed thereon);

3. subjecting the resulting layer to a treatment with an aqueous liquid (usually by immersion of the film in a bath containing mostly cool water) to thereby cause the dope to "gel" and thus form a membrane having sufficient integral strength to retain its physical shape and structure upon being removed from the casting web (this step is known as the initial "quench" step); and

4. subjecting the washed membrane to a special heat treatment (which step is known as the "heat tempering" step), in which the salt rejecting properties of the membrane are increased apparently because of a general shrinkage of the membrane during heat tempering.

This process clearly does not correspond to the applicant's because the cast film is exposed to air or other gaseous atmosphere for a certain period, to produce an incipient change in the exposed surface. Then, after the dope has gelled by immersion of the film in a bath containing mostly cool water, the membrane is subjected to a special heat treatment, which also is not required by the applicant. In addition, the "quench" step uses cool water, not an aqueous formic acid solution or similar, such as is employed by the applicant.

Brown et al modify this process by forming the membrane directly on a support. Brown et al describe this from line 56 at the bottom of column 4 and the top of column 5 to line 13 as follows:

> It has now been found that the prior art disadvantages found in attempting to use a woven fabric, such as a fabric woven from Dacron polyester, e.g. D-601 fabric, as a support member for a semi-permeable polymeric, preferably cellulosic, film membrane in an integral membrane suitable for use in reverse osmosis processes, are substantially avoided and overcome by a process for forming an integral membrane which comprises (1) subjecting at least one surface of a substantially unsized, fluid-permeable fabric comprising multiple substantially continuous warp and full multlifilament strands of fiber-forming crystalline organic thermoplastic resin to high pressing forces at temperatures and pressures sufficient substantially completely to close permanently the interstices at the strand intersections while leaving the pressed fabric permeable to fluids, such as gas and desalinated water, and sufficient to smooth said surface(s) of the fabric to a high degree of smoothness, (2) cooling the pressed fabric to a temperature at least sufficiently cooler than the pressing temperature to set the fabric in its permanently pressed form, (3) casting onto a smooth surface of the fabric a concentrated polymeric, preferably cellulosic, film-

> forming dope, and (4) subjecting the dope on said fabric to subsequent steps of a known reverse osmosis membrane forming process.

Thus, Brown, et al retain all of the usual steps of the conventional process for preparing reverse osmosis membranes, with the addition of the support.

The Examiner apparently referred to Brown et al to show the use of a support. The applicant fails to see how Brown et al's use of support, in a rather different film-casting process using cellulosic membranes, can suggest anything to one interested in preparing polyamide resin membranes. But, assuming for the purpose of argument that the combination of Brown et al to the extent that the support is shown with Marinaccio et al is proper, nonetheless one skilled in the art still has to modify the Marinaccio et al process for forming a membrane to add the support. The applicant fails to see how one skilled in the art would know from Brown et al how to apply the support in the Marinaccio et al process. It seems from Brown et al that the process requirements for forming a membrane in the presence of the fabric can hardly be met in the Marinaccio et al process without completely revising the process.

For example, Brown et al describe the procedure for preparing their membrane in Example 1, and the same procedure was used in the following Examples. In this procedure, the fabric substrate is impregnated with the dope used to form the membrane. The cast film of membrane forming dope and fabric substrate then are dried in air, after which the membrane is immersed and quenched in water. Application of the Brown et al process in Marinaccio et al would suggest the interposition of the drying step, because of the use of the fabric substrate, but there is no reason in

Marinaccio et al to use such a step. If one does not use it, one is not following Brown et al, however. What then is one skilled in the art to do? The combined references do not say.

In any case, since the Brown et al disclosure is not concerned with polyamide membranes, there is nothing to suggest modification of the Marinaccio et al process, which is concerned with nylon membrane, so as to approximate the applicant's by introduction of the features of the applicant's process described above and not shown or suggested in either reference.

Accordingly, it is respectfully submitted that the claims should be regarded as patentable over the combination of Marinaccio et al and Brown et al under 35 U.S.C. 103.

Claims 3 and 4 were rejected as unpatentable over Marinaccio et al in view of Brown et al and Jamison under 35 USC 103. The Examiner asserted that it would be obvious to filter the casting dope of Marinaccio et al according to Jamison at column 4, lines 44 to 49. However, the Jamison reference does not remedy any of the deficiencies of the Marinaccio et al disclosure with respect to nucleation.

Jamison is concerned with a method for forming a film from a difficulty-meltable sulfuric acid-soluble film-forming polymer. The film is transparent, and it is also apparently nonporous. There is no reference anywhere in the patent to a porous film. Neither for that matter is there any indication that the film is hydrophilic. Moreover, the process used is not a casting process, but an extrusion process. In the broad description of the invention beginning at the bottom of column 1, Jamison et al state:

> Broadly described, the instant invention provides a method of forming a film, more

particularly a transparent film (i.e., a film where in some or all portions of the film are transparent), from a difficultly-meltable, film-forming polymer by extruding a solvent solution of the polymer through a slotted opening into a liquid coagulating bath ("spin" bath) in which the said polymer is insoluble thereby to form a gelled film of the polymer, which film is at least partly non-transparent after drying (i.e., after conversion to solid or non-gelled state). The gelled film after leaving the extrusion head is subjected to at least one physical treatment that renders the said film transparent after drying. This physical treatment, which hereafter will be described, is other than the continuous physical treatment that the freshly-formed film receives during its contact with the liquid in the coagulating bath during its passage through said bath from the point of formation of the film at the extrusion head to the point where it leaves the bath. Thereafter the gelled film is dried. Drying may take the form of a positive action such as subjecting the tensioned or untensioned film to an elevated temperature in a drying zone, or the film may be allowed to dry at room temperature either in tensioned or untensioned state.

Thus, this process is not at all analogous to Marinaccio et al and it is different again from Brown et al.

The Examiner referred to column 4, lines 44 to 49 of Jamison et al, where Jamison et al suggest that the film-

forming dope be preferably filtered and be aerated before use, that is, before it passes into the extrusion device. Just preceding this portion, Jamison et al have described the dissolution of the polymer in sulfuric acid containing at least 70% and preferably at least 75% by weight of sulfuric acid, to give a dope with a 5 to 30% by weight concentration of the polymer. There is nothing in the reference about conditioning the dope, and of course a film is not formed on a substrate before the dope is brought in contact with the liquid coagulant in the extrusion bath. Thus, the filtration is apparently for the purpose of removing undissolved resin particles, and insoluble foreign matter. These are not what claims 3 and 4 call for filtering out. Claims 3 and 4 call for filtration of precipitated (i.e. originally dissolved) resin particles.

There is certainly nothing in Jamison et al that would lead one to suppose that the Marinaccio et al dope could be or should be filtered, since the processes are entirely different. After all, Marinaccio et al avoids precipitation of resin particles and Jamison doesn't have any such particles either. While filtration may be desirable in the Jamison process, it has no purpose in Marinaccio et al's. There is certainly nothing in either reference that would lead one to combine them, and even when combined, there is nothing to lead one to lift the filtration step out of the Jamison process, and use it in the Marinaccio et al process.

In any case, Jamison certainly does not add to Marinaccio et al any of the important features of the applicant's process, which is a casting process, not an extrusion process, like Jamison's. Accordingly, it is respectfully submitted that claims 3 and 4 should be regarded as patentable over Marinaccio et al in view of Brown et al and Jamison.

The claims also should be regarded as distinguished for the same reasons as claim 1, upon which they are dependent.

Claims 55 and 66 were rejected as unpatentable over Marinaccio et al in view of Brown et al and Pall et al under 35 USC 103. The Examiner asserted that it would be obvious to use multiple layers is shown by Pall et al in Marinaccio et al, as modified by Brown et al. The Pall et al reference shows only multiple layers, is not concerned with the preparation of skinless hydrophilic alcohol-insoluble polyamide resin membranes from polyamide resins that are hydrophobic to start with, and there is nothing in the combination of Pall et al, Marinaccio et al and Brown et al that would teach one skilled in the art how to carry out such a process or to obtain such a product. Accordingly, the claims should also be regarded as patentable over these combined references for the same reasons as claim 1. The combined references simply do not suggest even monolayer membranes which are skinless and hydrophilic, even though based on an alcohol-insoluble hydrophobic polyamide resin.

Claims 32 to 38 and 46 were rejected as unpatentable over Sharp with specific reference to Example 6, or Marinaccio et al under 35 USC 103. The Examiner asserted that the membrane of Sharp is hydrophilic, compared with nonporous polyethylene, for instance, but this argument is of course answered by Dr. Pall's comments and the showing in the Declaration.

The Sharp disclosure must speak for itself, and when the disclosure is viewed in its entirety, it is perfectly clear that the Sharp polymer is regarded by Sharp as hydrophobic. There is nothing in the reference to suggest that it is hydrophilic. A very thing, very porous film of polymer which is hydrophobic could not be wettable throughout, or even wetted at all.

The Examiner commented that Marinaccio et al show films "more readily wettable than prior art films", with reference to column 8, lines 41 to 42. What is stated here in the context of the entire paragraph is as follows:

The statement referred to clearly does not imply that a polyamide resin membrane that is hydrophilic can be obtained by the Marinaccio et al process.

First of all, whether or not a film is wettable depends upon the liquid that is used to do the wetting. A hydrophobic membrane can be readily wetted by hydrophobic organic solvents, and thus the Marinaccio et al statement could be perfectly true, if applied to a combination of a hydrophobic polymer and a hydrophobic organic solvent.

Secondly, the Marinaccio et al process is not limited to nylon. Example 8 shows application of the process to the preparation of a polystyrene film, and this film, according to Example 8, column 8, line 35, was permeable to hexane, which is a hydrophobic organic solvent. This means, since the film was readily wetted by hexane, that the film was hydrophobic. It is thus clear that the statement at column 8, lines 40 to 42 is clearly applicable to this membrane. Similarly, hydrophobic nylon membranes should also be readily wetted by hexane.

Thus, in fact, the statement referred to by the Examiner is just as applicable to the combination of hydrophobic organic solvents and hydrophobic polymers as it is to a hydrophilic polymer and water. It is impossible to determine from the statement, because of its breadth, which, if either, Marinaccio et al had in mind. It certainly does not follow from the statement, however, that the Marinaccio et al polymer is hydrophilic, and readily wetted by water. There is simply no inference nor any specific disclosure suggesting this to be the fact.

It is of interest that although the statement that the polystyrene membrane was permeable to hexane appears in Example 8, none of the Examples relating to nylon membranes (Examples 1 to 7) contains a similar statement with reference to a similar solvent. There is really nothing in any of the Examples or in data elsewhere in the text that supports the statement, or makes it possible to explain it, except for Example 8, which is only an example of a wetting of a hydrophobic polystyrene polymer with a hydrophobic solvent, not with water, as in the applicant's case.

Accordingly, it is submitted that neither the Sharp nor the Marinaccio et al references support this rejection.

Dr. Pall has explained why a very thin, very porous film would not be completely wettable throughout as claimed, and thus has disposed of the Examiner's position.

It is respectfully submitted, accordingly, in the light of the Declaration and the preceding argument, that the claims should be regarded as patentable over Sharp or Marinaccio et al under 35 USC 103, since neither reference suggests the possibility of a hydrophilic polyamide resin membrane that is readily wetted by water, and certainly neither reference suggests how such a membrane could be prepared.

Claims 39 to 45, 47 to 55 and 67 to 74 were rejected as unpatentable over Sharp or Marinaccio et al in view of Pall et al under 35 USC 103. These claims are directed to multilayer structures, and the Examiner referred to Pall et al for a disclosure of multilayer structures to supplement the disclosures of Sharp and Marinaccio et al. However, the Pall et al reference is not concerned with the preparation of resin membranes, and does not remedy any of the deficiencies of Sharp or Marinaccio et al with respect to the applicant's hydrophilic polyamide resin membranes that are readily wetted by water, whether or not they are multilayer.

Accordingly, it is submitted that the claims should be regarded as patentable over these combinations of references under 35 USC 103, for the same reasons as claims 32 to 38 and 46.

Claims 75 to 86 were rejected as unpatentable over Marinaccio et al in view of Jamison and Lovell under 35 USC 103. These claims are no longer presented in this application.

In view of the foregoing it is considered that all of the claims as now presented should be regarded as patentable over the references cited in Serial No. 905,698, and that the claims should be allowed. A favorable action is respectfully requested.

Respectfully submitted,

JOHN R. JANES

/s/_____
Attorney for Applicant
(516) 938-2330

2-229 CIP

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Examiner:	F. Spear Group Art Unit: 176
Applicant:	David B. Pall
Serial No.:	198,569
Filed:	October 20, 1980
For:	PROCESS FOR PREPARING HYDROPHILIC POLYAMIDE MEMBRANE FILTER MEDIA AND PRODUCT

P.O. Box No. 1
Jericho, New York 11753

AMENDMENT

Hon. Commissioner of Patents & Trademarks
Washington, D.C. 20231

Sir:

In response to the outstanding Official Action of August 24, 1991, and in accordance with the discussion at the Interview of October 1, 1981, please amend this application as follows:

In the Claims:

Please amend claim 87 as follows:

-- 87. A process [according to claim 77] for preparing skinless hydrophilic alcohol-insoluble polyamide membranes that are readily wetted by water which comprises preparing a solution in a polyamide solvent of [in which the polyamide resin is] a mixture of polyamide resins of which at least one is [has] an alcohol-insoluble polyamide resin having a CH_2:NHCO ratio of methylene

CH_2 to amide NHCO groups within the range from about 5:1 to above 7:1; and at least one is [has] an alcohol-insoluble polyamide resin having a CH_2: NHCO ratio exceeding 7:1, in proportions such that the average CH_2:NHCO ratio is within the range from about 5:1 to about 7:1; inducing nucleation of the solution by controlled addition to the solution of a nonsolvent for the polyamide resin, under controlled conditions of concentration, temperature, addition rate, and degree of agitation to obtain a visible precipitate of polyamide resin particles, thereby forming a casting solution; spreading the casting solution on a substrate to form a thin film thereof on the substrate; contacting and diluting the film of casting solution with a nonsolvent liquid for the polyamide resins, thereby precipitating polyamide resin from the casting solution in the form of a thin skinless hydrophilic membrane; washing the membrane to remove solvent; and drying the resulting membrane. --

REMARKS

The courtesy and assistance of the Examiner at the interview of October 1, 1981 were greatly appreciated, and are acknowledged with pleasure. Claim 87 is amended so as to put it in independent form, incorporating all of the subject matter of claim 77, thus avoiding the issue raised in the Official Action. As thus amended, claim 87 appears to be acceptable in form, and of course distinguishes the references noted.

The Examiner in the Official Action rejects claims 77 to 110 and 116 to 162 under 35 U.S.C. 112, indicating that the broadly recited polyamide having the claimed ratio of CH_2:NHCO groups is unwarranted in view of the disclosure. Reconsideration of this rejection is respectfully requested, inasmuch as it is considered to be unwarranted.

The range of CH_2:NHCO ratios within the range from about 5:1 to about 7:1 is actually rather narrow, and it is moreover well supported in the disclosure. The ratio of 5:1 requires there to be five CH_2 to one NHCO group, and the ratio of 7:1 requires that there be seven CH_2 groups to one NHCO group. These limits constrain a rather narrow range of CH_2:NHCO ratios, and clearly exclude the vast majority of polyamide resins, all of which can of course be prepared from diamines and dicarboxylic acids or aminocarboxylic acids having a virtually infinite number of carbon atoms, in virtually infinite permutations.

The specification at the bottom of page 22 lists a number of commercially available polyamide resins that fall within the limits of the ratio range, and these are as follows:

Nylon 6	$[(CH_2)_5CONH]_n$	5:1
Nylon 66	$[(CH_2)_6NHCO(CH_2)_4CONH]_n$	5:1
Nylon 610	$[(CH_2)_6NHCO(CH_3)_8CONH]_n$	7:1
Nylon 7	$[(CH_2)_5CONH]_n$	6:1
Nylon 69	$[(CH_2)_6NHCO(CH_2)_7CONH]_n$	6.5:

Mixtures of these with each other or with polyamides outside the range but with an average ratio within the limits as well as other polyamides within the range can of course be conceived, but the above should make it clear that those listed are virtually all of the permutations based on hexamethylene diamine, or on aminocarboxylic acids, of which only Nylon 8 $[(CH_2)_6CONH]_n$ is not specified.

In addition, the Examples illustrate Nylon 66, Nylon 7, Nylon 69 and Nylon 610, as well as a mixture of Nylon 66 and Nylon 612 that has the required average ratio based on the ratios of the two components.

Accordingly, it is considered that claims 77 to 110 and 116 to 162 should be found acceptable in scope, and allowable, as have been claims 1 to 76 and 111 to 115.

It is noted that the references are cited to show the state of the art. They have indeed been distinguished as pointed out in the discussion in the preliminary amendment filed December 22, 1980. This the Examiner evidently appreciates, having allowed a large proportion of the claims in this case already. The remaining claims should now be allowed, and the case put in order for the payment of the final fee, since the applicant is anxious to obtain a patent.

Respectfully submitted,

JOHN R. JANES

/s/_____
Attorney for applicant
(516) 938-2330